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BULLETIN OF THE

TAYLOR SOCIETY

AN INTERNATIONAL SOCIETY TO PROMOTE THE SCIENCE
AND THE ART OF ADMINISTRATION AND OF MANAGEMENT

Major Article on

METHODS STUDY

By KING HATHAWAY

and

Short Contributions

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OCTOBER, 1930 VOL. XV, NO. 5

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The objects of this Society are, through research, discussion, publication and other appropriate means:

1. To secure—for the common benefit of the community, the worker, the manager and the employer—understanding and intelligent direction of the principles of administration and management which govern organized effort for accomplishing industrial and other social purposes.

2. To secure the gradual elimination of unnecessary effort and of unduly burdensome toil in the accomplishment of the work of the world.

3. To promote the scientific study and teaching of the principles governing organized effort, and of the mechanisms of their adaptations and application under varying and changing conditions.

4. To promote general recognition of the fact that the evaluation and application of these principles and mechanisms are the mutual concern of the community, the worker, the manager and the employer.

5. To inspire in labor, manager and employer a constant adherence to the highest ethical conception of their individual and collective responsibility.

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ANNUAL MEETING

December 3-5, 1930

HOTEL PENNSYLVANIA, NEW YORK

(See outside back cover for detailed program.)

Comment

THE article, "Methods Study," in this issue is not merely the record of a paper presented at a meeting of the Society, its preparation was requested as a first step in preparation for an inquiry on an international scale into methods of management, standardization and control of work.

THE program of the December Meeting, of which a condensed outline will be found on the outside back cover, strikes us as exceptionally strong all along the line. It includes the customary papers on important phases of management by competent authorities, and in addition two committee reports and a symposium.

A REPORT of a joint committee of the National Association of Credit Men and the Taylor Society will offer, *a propos* the general question of the need of balance sheets of management to supplement financial statements as a basis for credit rating, two suggestive forms of management balance sheets, one pertinent to manufacturing and the other to retail enterprises. It is obvious that discussion of these will be of interest to other than credit executives, for they raise the broad question "What are the ear-marks of good management?"

A REPORT of the Industrial Code Committee appointed early in the year by President Kendall is a significant event, for we do not know of an association which has ventured to formulate a code of employer-employe relations which goes straight to the heart of the problem. Although the tentative code which will be offered for discussion is not a definitive report of the Committee, and is offered at the present time because the Committee seeks aid by co-operative thinking out loud, we assure our readers that it contains material of the greatest interest. The symposium will continue the discussion of economic balance begun last year, and will focus about the inquiry whether present industrial disequilibrium is not a challenge to apply the scientific management principles of planning and control over a larger area than the individual plant; whether we can continue to operate successfully a technically integrated national industry by the method of individual intuition.

Methods Study[1]

The Principles and Technique of Analyzing Work Methods

By **KING HATHAWAY**
Manning, Maxwell & Moore, Inc., New York

I. Introduction

Objects of Paper—Historical Basis of Motion Study

IN PRESENTING this paper my objects are:

1. To define the fundamental principles involved in the study and analysis of methods of doing work, which Taylor and his associates designated inadequately, and I believe unwisely, by the simple expression "elementary time study."

2. To review and summarize the history and development of methods-study technique and to point out what appear, in some present practice, to be inconsistencies or violations of principle which may reduce its value and lead to difficulties.

3. To indicate phases of methods study, and the utilization of the results, in which research work is needed.

4. To contribute to building up synthetically a technique which may serve as a tentative standard. This should embody that existing practice which is not inconsistent with fundamental principles.

Before 1916 literature on this subject was quite meager. It consisted chiefly of Taylor's paper entitled "A Piece-Rate System," presented before the A. S. M. E. in 1895, Gantt's paper "A Bonus System for Rewarding Labor," presented before the A. S. M. E. in 1901, and Taylor's classic "Shop Management," presented before the same society in 1903.

Anyone interested in any branch of scientific management, and particularly those actively engaged in this branch, may derive profit from a discriminating reading or rereading of these three papers. Taylor's paper, "A Piece-Rate System," based solely upon his Midvale experience, and Gantt's paper, "A Bonus System for Rewarding Labor," which included experience gained during another six years, both directed attention by their titles to incentive wage systems embodying the same basic idea. They made what was actually of far greater importance—analysis of work and the determination of tasks, with all they involved—seem of secondary importance. In "Shop Management" Taylor made an attempt to correct this by a broader discussion of the art of management. He also more fully described there the technique of time study as it then existed.

In retrospect, it is obvious that it would have been better had Taylor and Gantt each presented two separate and distinct papers, one dealing with the study and analysis of shop operations, methods and conditions related thereto, and the manner in which the results of such studies were used in the setting of tasks, and the other dealing with the novel system evolved by the particular author of rewarding labor for the accomplishment of tasks, based upon the results of elementary time study.

A casual reading of these papers, especially by the uninitiated, gives the impression that "elementary time study" or "the study of unit times" was undertaken not so much *with the primary motive of increasing production through improvement in method* as with the object of ascertaining scientifically what a "first-class" man, working at his best speed with the then prevailing method, could do. Increase in production apparently was to be attained largely by greater effort of the worker. This seeming emphasis upon the willingness of the worker to put forth unusual effort, i. e., to work hard rather than hold back or soldier, upon *his* responsibility for attaining a high rate of production, and upon the exercise of his initiative, led Taylor's contemporaries to regard these things as of major importance. This is understandable when we consider that, even at that time, craft knowledge and skill were considered the property of the worker, his stock in trade. They were in general regarded as no concern of those in higher managerial positions. Engineers in common with managers shared largely in this viewpoint. Such statements as the following from Taylor's "A Piece-Rate System" show that, while he had cut loose from the old viewpoint and practices of management, he was still in a great measure influenced by prevailing conditions and ideas: "As soon as the men recognize that they have free scope for their proper ambition, that as they work harder and better their wages are from time to time increased. . "; "That the workmen in nearly every trade can and will materially increase their present output per day, providing they are assured of a permanent and larger return for their time than they have heretofore received." And in replying to discussion by Mr. F. A. Halsey, who by the way, wisely pointed out that the superiority of Mr. Taylor's system over piece work lay "not in the advancing piece rate but in the method of fixing rates," Taylor said: "It is quite true that under the differential rate the workmen earn higher wages than under other systems, but it is not that they get a higher price per piece *but because they work much harder, because they feel that they can let themselves out to the fullest extent* without going against their own interest in the long run." This emphasis on the worker's part in increasing production was further heightened by Taylor's references to "soldiering," then a very real obstacle to industrial progress but understandable and excusable today when one considers that "soldiering" had its roots in many basically unsound economic theories growing mainly out of a fear, based on experience, of unemployment. Soldiering was not primarily due to laziness or unwillingness to do a proper day's work under more satisfactory conditions. The injustices of ordinary piece work as then practiced, and even in some cases as practiced today, were a justifiable excuse for "soldiering"—as was also bad management generally.

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[1] Paper presented before a meeting of the Taylor Society, New York, December 6, 1929.

Such statements as I have quoted, together with the frequent reference to "rate fixing," had the effect of obscuring other matters which, in the light of present-day experience, are of predominant importance. Nevertheless, these other matters were not neglected, as will be evident to anyone who looks for them. I refer particularly to improvement in method or prevailing practice, resulting from improvement and standardization of equipment, of materials and conditions, and of service by others to the worker. In the absence of such improvements the most skillful and willing employe could not have attained what Taylor referred to as "maximum production" or what elementary time study established as a standard. For example, in "Shop Management," the following significant statement, referring to work at Bethlehem, appears: "In almost all of the other more complicated cases, the large increase in output is due partly to physical changes, either in the machines or small tools and appliances, which a preliminary time study almost always shows to be necessary. . ." I recall also hearing Taylor talk of the "art of shoveling," developed at Bethlehem as a consequence of studies which resulted in his having special shovels made, each of an appropriate shape and size, to hold a quantity weighing twenty-one and one-half pounds of materials such as coal, coke, limestone, cinders and shavings. I have seen him illustrate, as he described it, the right method of shoveling. He made the most effective use of the worker's strength with a minimum of fatigue, showed the need for and effect of rest periods, and used an iron plate to facilitate filling the shovel. In unloading cars, the coal or similar materials were slid or pulled across this plate.

As we progress it becomes increasingly evident that studies undertaken for the purpose of increasing production may have more to do with physical things and with service to the worker than with the worker's own effort. The method adopted and the results attained are often governed by and dependent upon conditions over which the worker has little or no control. And this may involve conditions or activities seemingly remote or disassociated from the operation under consideration. Typical of this is the development of a standard practice and system of maintenance in the transmission of power by leather belting, described by Taylor in his paper "Notes on Belting," presented before the A. S. M. E. The influence of time study upon conditions which are beyond the worker's control, but which nevertheless govern or influence both the method to be followed and the results of the worker's effort, was clearly indicated by such statements by Taylor as the following:[2]

> . . . not the least of the benefits of elementary rate fixing are the indirect results.
>
> The careful study of the capabilities of the machines . . . almost invariably results in first indicating and then correcting the defects in their design, and in the method of running and caring for them. . . . They (The Midvale Steel Company) have themselves been obliged to superintend the design of many special tools which would not have been thought of had it not been for elementary rate fixing.

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[2] Taylor, F. W., "A Piece-Rate System," *Transactions of the American Society of Mechanical Engineers,* Vol. XVI, 1895. pp. 877, 881, 895.

> But what is, perhaps, of more importance still, the rate-fixing department has shown the necessity of carefully systematizing all of the small details in the running of each shop; such as the care of belting, the proper shape for cutting tools, and the dressing, grinding, and issuing same, oiling machines, issuing orders for work, obtaining accurate labor and material returns and a host of other minor methods and processes. These details, which are usually regarded as of comparatively small importance, and many of which are left to the individual judgment of the foreman and workmen, are shown by the rate-fixing department to be of paramount importance in obtaining the maximum output, and to require the most careful and systematic study and attention in order to insure uniformity and a fair and equal chance for each workman. Without this preliminary study and systematizing of details, it is impossible to apply successfully the differential rate in most establishments.
>
> . . . really successful application not only involves a thorough organization but requires the machinery and tools throughout the place to be kept in such good repair that it will be possible for the workmen each day to produce their maximum output.
>
> . . . what is of equal importance is, that it spurs the firm to keep their shop in the best of order. Everything must be kept up in the finest state of repair, or the men cannot earn their differential rate, and I think, if possible, that this indirect result of the system is a greater benefit to the firm than the rate is itself.

From my own observation while a workman and foreman at Midvale a few years after Taylor had left, it was evident that improvement in method, growing out of studies undertaken for purposes of rate fixing, was an important factor in the increase of production. "Laying out" of work on a surface plate previous to machine tool operations was carried far beyond the practice prevailing even in the best shops of that day. For the benefit of those not familiar with machine shop practice I should explain that "laying out" consists of accurately marking on castings or forgings lines that will facilitate the setting of work on machine tools, save time in accomplishing it, insure accuracy of results, indicate the location and size of cuts to be taken on various surfaces, the holes to be drilled, etc. This is not only done more accurately and conveniently on a surface plate by a man specializing in such work, with certain direct advantages, but—and this is of greater importance—the machine is actually permitted to run a greater part of the time, which means an increase in output without an increase in investment or overhead. Another practice embodying the same principle was illustrated by the use of a chuck or device for holding forgings, such as hoops for naval guns, while being machined. These chucks consisted of a base fastened to the machine table, into which fitted a detachable upper portion holding the work. For each machine there were two of the upper or work-holding sections so designed that forgings set in them on a surface plate apart from the machine would be properly centered when the upper part containing the forging was dropped into place on the base section on the machine. While one forging was being machined another to follow it was being prepared on a surface plate. These are but two of many cases indicating that *methods study* was practiced to a greater extent in Taylor's Midvale days than would appear to the average reader of his "A Piece-Rate System," or even his "Shop Management." However, one example of methods study described in "Shop Management"[8] is remarkable for its thoroughness as well as for the fact that it covered a maintenance operation rather than a production operation. I remember seeing these or similar instruction cards, in Taylor's own handwriting, which compare favorably with the best present-day practice.

> After the writer had become convinced of the economy of standard methods and appliances, and the desirability of relieving the men as far as possible from the necessity of doing the planning, while master mechanic at Midvale, he tried to get his assistant to write a complete instruction card for overhauling and cleaning the boilers at regular periods, to be sure that the inspection was complete, and that while the work was thoroughly done, the boilers should be out of use as short a time as possible, and also to have the various elements of this work done on piece work instead of by the day. His assistant, not having undertaken work of this kind before, failed at it, and the writer was forced to do it himself. He did all of the work of chipping, cleaning and overhauling a set of boilers and at the same time made a careful time study of each of the elements of the work. This time study showed that a great part of the time was lost owing to the constrained position of the workman. Thick pads were made to fasten to the elbows, knees and hips; special tools and appliances were made for the various details of the work; a complete list of the tools and implements was entered on the instruction card, each tool being stamped with its own number for identification, and all were issued from the tool room in a tool box so as to keep them together and save time. A separate piece-work price was fixed for each of the elements of the job and a thorough inspection of each part of the work secured as it was completed.
>
> The instruction card for this work filled several typewritten pages, and described in detail the order in which the operations should be done and the exact details of each man's work, with the number of each tool required, piece-work prices, etc.
>
> The whole scheme was much laughed at when it first went into use, but the trouble taken was fully justified, for the work was better done than ever before, and it cost only eleven dollars to completely overhaul a set of 300 H. P. boilers by this method, while the average cost of doing the same work

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[8] Taylor, F. W., *Shop Management*, Harper & Brothers, New York, 1911, pp. 181-182.

on day work without an instruction card was sixty-two dollars.

In his paper, "A Bonus System for Rewarding Labor," Gantt indicated more specifically the importance of methods study, or seeking to develop what Gilbreth aptly designated "the one best way," by the following statement:

> . . . instruction cards may be made out to show the best method of doing the work which we can devise with our present knowledge and appliances. Such cards will seldom represent the very best method of performing the work but will usually represent a method far superior to that which the ordinary workman would employ, and if we can get the men to do the work as directed on these cards we can very largely increase the efficiency of their work. . . It is hard to over-estimate the value of a *complete set of instructions showing the best method* of performing a piece of work.[4]

Again, in a paper presented in 1908, Gantt directs attention to the part played by "scientific investigation" in effecting improvement in methods, saying:

> The fact, so repeatedly emphasized by Mr. Taylor, that *tasks should be set only as the result of a scientific investigation*, has proved of an educational value hardly to be over-estimated, for the scientific investigation of a process that has been developed without the assistance of science almost always reveals inconsistencies which it is possible to eliminate, thus perfecting the process and at the same time reducing its cost.
>
> It is the duty of the investigator to develop methods and set tasks, and unless the methods developed by him are pretty generally a great deal better than those suggested by the workmen, he is not retained in the position. Working at tasks is pretty good training for task setting, and the writer has gotten more than one task setter from the ranks of task doers.
>
> . . . the best expert available investigates the work, standardizes the appliances and methods and sets a task that involves utilizing them to their very best efficiency. While the stop watch is often used to establish a method, it is used to determine the time needed to do the work only when the standard methods and appliances are used efficiently. Stop-watch observations on work done inefficiently or with ill-adapted appliances, or by poor methods, are absurd and serve only to bring into disrepute all work in which the stop watch is used. Moreover, such use of the stop watch justly excites the contempt and opposition of the workman.
>
> To make real and permanent progress, the expert must be able to standardize appliances and methods and write up such instructions as will enable an intelligent workman to follow them.[5]

That such studies as Gantt refers to included what is now frequently spoken of as "motion study" was brought out in the discussion of Gantt's paper, "Training Workmen in Habits of Industry and Co-operation."

> One of the operations on this job was the setting of the piece in a jig, the man who was put on it taking regularly 1 min. 40 sec. After a study of the exact motions required to pick the piece up and set it accurately we showed the same man how to do it in 20 sec. . . . distinction should be sharply drawn between work done at high speed and work done in a hurry; the first will give perfect goods because the speed is attained by elimination of all the unnecessary motions, the latter bad work because it is a speeding up of all the operations, necessary and unnecessary.[6]

My principal object up to this point has been to show that what Taylor and his associates referred to as "the study of unit times," "elementary rate fixing," "the study of elementary operations," "time study" or "scientific time study" embodied in fact and in principle, if not in terminology, all that today is considered under the headings "time study," "motion study," or "standardization." As Colonel Babcock says in his chapter, "Research for Production," in the recently published book of the Taylor Society, "Scientific Management in American Industry"[7]: "In Taylor's day time study and motion study were not considered separately; although he sometimes used the term 'motion study,' Taylor usually used the term 'time study' to cover both." Carl G. Barth in his foreword to the book, "Time Studies for Rate Setting"[8] by Dwight V. Merrick, said of time study work undertaken by men not properly qualified for it: ". . . time studies cannot be separated from motion studies, and motion studies cannot be made by a person who does not fully appreciate the purpose of the motions made by the operator he observes."

The importance of the study of motions becomes increasingly obvious in efforts to improve and establish standard methods and performance standards for simple repetitive operations where all or most of the work is done by hand. It is also of sufficient importance to justify its being given more consideration than it usually receives in varied product and varied operation industries, such as the general machine shop or foundry. In the latter class of work the study of isolated groups of elements, composing frequently occurring elementary or suboperations, encourages and facilitates the study of motions.

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[4] Gantt, H. L., "A Bonus System of Rewarding Labor," *Transactions of the American Society of Mechanical Engineers*, Vol. XXIII, 1902, pp. 346 and 347.

[5] Gantt, H. L., "Training Workmen in Habits of Industry and Co-operation," *Transactions of the American Society of Mechanical Engineers*, Vol. XXX, 1908, pp. 1038 and 1043.

[6] *Ibid*, p. 1055.

[7] Harper & Brothers, New York, 1929, p. 91.

[8] Engineering Magazine Company, New York, 1919, p. viii.

The late Frank B. Gilbreth, probably to a greater extent than any one else identified with the scientific management movement, realized the full importance of study of the motions involved in the performance of work. The machinist's time and energy are saved by delivering and placing materials so that they are convenient to his machine, by standardizing his tools and furnishing him with those best suited to each of his jobs (for instance, a wrench to fit each size of nut to be tightened instead of one adjustable monkey wrench which requires a number of time-consuming motions). He realized that this same principle might with profit be more consciously and extensively applied.

The scientific management movement is indebted to the Gilbreths not only for focusing attention upon this feature of Taylor's philosophy and setting it forth in the light of its true importance but for refining and developing its technique along truly scientific lines, for reducing and codifying its fundamentals and setting, by years of persevering effort, a new standard which industry is just beginning to understand and make an effort to attain.

The bricklaying system developed by Gilbreth while he was engaged in large-scale building construction work, an outgrowth of his early contacts with Taylor and his associates, was an example of methods study embracing standardization of equipment, study and economy of motions, planning and control of materials supply and auxiliary service to the worker. It impressed Taylor so much that he referred to it in his "Principles of Scientific Management,"[9] and frequently cited it as an illustration, along with the classic examples of pig-iron handling and shoveling.[10]

Any methods man, whether he is engaged in highly specialized, repetitive work or in work of a varied and complicated character, will benefit by a study of the refinements of technique and the basic rules developed by the Gilbreths. As I have intimated they may be profitably adapted and applied more extensively than is commonly supposed.

All of this—the study of machinery, of implements, of materials upon which work is to be done and of the motions of the worker in performing a productive operation, of surrounding conditions and auxiliary services that affect the performance of work—may, I believe, be better expressed by the term *methods study*. Time study or time measurement, regardless of the instrument employed, should be considered only as a means in the study of methods. In my own work of installing systems of scientific management I came without much consideration to apply the term "methods section" to that functional division of the planning department having to do with time study and instruction cards. I designated its head as the chief methods supervisor and his representatives in the shop, the functional foremen formerly designated as "speed bosses" or "instructors," as "shop methods supervisors." It is significant that in recent papers dealing with this subject others have independently adopted designations such as "methods department," "methods function," etc., in place of "time study." It was, however, during my recent visit to Japan, where I was called upon to inspect in a professional capacity a number of industrial establishments, that I was impressed with the need for a more comprehensive term to express all that Taylor and his associates included in the term "time study." I found myself constantly calling the attention of managers and other executives of plants that I examined to the need for critical analysis and study of *methods* and discussing the possible improvement of *methods* suggested by even my brief examination.

Mr. Barth pointed out in discussing my paper on "Standards," that time study may not be necessary to the detection of faulty conditions or wasteful motions:

> Such motions are best ferreted out by common-sense observations on the part of a person well versed in the trade, who has caught the right spirit, without any time study. The time study properly comes later, and may then be made by a person less expert in the trade; but no amount of mere time study of an unstandardized complex operation will directly lead to the elimination of its useless or wasteful motions. However, such time studies submitted to the scrutiny of a person well versed in the art may be that person's indirect method for detecting and eliminating useless and wasteful motions. Because of the misconception referred to, a lot of worthless time study is being made the country over by mere stopwatch men. Time study should not be taken up until conditions of machines, tools, materials and motions have all been properly studied in an everyday, common-sense and expert manner, and later standardized on the strength of the information thus gained.[11]

Gantt wrote in 1908: "While the stop watch is often used to establish a method, it is used to determine the time needed to do work only when the standard methods and appliances are used efficiently."[12]

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[9] Taylor, F. W., *Principles of Scientific Management,* Harper & Brothers, New York, 1911, p. 77.

[10] "Testimony before the Special Committee of the House of Representatives," reprinted in *Bulletin of the Taylor Society,* Vol. XI, No. 3-4, June-August, 1926, p. 117.

[11] *Bulletin of the Taylor Society,* Vol. X, No. 1, February, 1920, p. 40. Article reprinted in Vol. XII, No. 5, October, 1927, and Vol. XII, No. 6, December, 1927.

Nevertheless, there are instances in which even preliminary studies of methods and efforts at standardization are aided and expedited by time study. These incidental or preliminary time studies indicate the relative importance of various components of an operation, points at which irregularity occurs or where opportunities for improvement lie, many of which would not appear in their true light and some not at all from observation without time measurement. This is particularly true in the case of operations consisting of some eight or ten elements, the performance of which takes, let us say, a total of from only one-tenth to one-half minute. Frequently there may exist and even be practiced by different operators two or more ways of doing the same operation or parts thereof and a correct decision as to which is best may be reached only by time measurement. I have known people, including myself, to be fooled in assuming that one method of performing a simple repetitive operation was better than another, judging by appearance alone, only to find when timed that what appeared to be the slower way was the better. Likewise it seems, for some reason which no doubt the psychologist could explain, that the use of a stop watch in studying work quickens one's perception.

It would, I believe, be unwise to lay down or accept any hard and fast rule as to the stage in establishing standards or studying methods at which one should start making time measurements. For example, it would be as unwise to say that *actual time studies should in no case be made until after all conditions have been perfected* and the method to be adopted decided upon, as it would be to say that *no study or analysis of an operation and no improvement in conditions or method should be attempted until after a minute time study has been made.* Common sense and sound judgment based upon and utilizing experience must be our guide.

With regard to the human element, in spite of the emphasis that was seemingly laid by Taylor, first, upon inducing greater effort on the part of the worker, and, second, upon the improvement of physical conditions and services to the worker, as far back as 1895, as indicated by his paper, "A Piece-Rate System," presented at that time, Taylor was profoundly conscious of the importance of dealing with workers in such a manner as to engender mutual respect, and even cordiality, between management and workers. In short, he realized the importance of creating and maintaining that spirit which is essential to sound industrial relations. He was fully aware of the existence of and the need for taking into account the "human element," a fact which has too often been overlooked by those interested in the social aspects of management. Taylor and his early associates took for granted and practiced as a matter of course what is sometimes spoken of as "human engineering" and is often erroneously regarded as something new and apart from applied scientific management.

It must be borne in mind that in such simple expressions as "proper rate-fixing department" and "differential piece work" Taylor summed up all of the principles, practices and mechanisms that constituted in embryo what we today know as scientific management. A term such as "ordinary piece work" was used by him as a symbol of all that was bad in ordinary shop management.

Treating men like machines, an assertion made by some of the opponents of scientific management without taking the trouble to learn the facts, was far from Taylor's thoughts. This is indicated by paragraphs 85 to 88 in his first paper[13] on the art of management. (These were repeated by Taylor in "Shop Management.")

Fairness, justice and humane treatment are there set forth as essential to the success of management in dealing with workers. He believed that trouble could best be cured by eliminating the cause. As low wages, unfair piece rates and lack of knowledge in regard to the doing of work were at the bottom of most of the dissatisfaction in manufacturing plants, his first concern was to supplant them with something better.

However, neglect of the human factor by those lacking in understanding and experience has no doubt been *one* of the errors that has stood in the way of achieving the most satisfactory results from the utilization of "time study" which *"is by far the most important element in scientific management,"* as Taylor said in "Shop Management." He further said that he regarded time study as the "keystone in the arch" of an applied system of scientific management and that "the arch without the keystone would fall to the ground." He might also have said that the keystone alone would be useless without foundation, supports and the other stones which compose the arch. To these supporting members might be likened establishment and maintenance of physical standards, functional organization, selection and training of personnel, a system of planning and control, and all the other services auxiliary to production and management as well as sound industrial relations. He was quick to see the need for all these and to supply them.

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[12] "Training Workmen in Habits of Industry and Co-operation," *op. cit.*, p. 1043.

[13] "A Piece-Rate System," *op. cit.*, pp. 880-881.

Much present-day practice of time study and the utilization of its results are open to criticism, and this is due, I believe, to a failure to understand fully the objects and governing principles as Taylor conceived them. If one has lost one's way, it is sometimes best to go back to the starting point to get one's bearings. I believe every methods man will be helped by a more discerning reading of the Taylor and Gantt papers to which I have referred, followed by an unbiased checking up of his own practice.

II. Principles and Purposes of Methods Study

All that is reflected or implied by the foregoing may be summed up in the following statement of what appear to me to be the fundamental principles by which methods study should be governed.

1. Critical analysis of work to be done and its reduction into elementary component operations.

2. Comparison of the method, equipment and conditions governing the work being studied with, so far as it can be ascertained, the best existing practice followed elsewhere and the facilities pertaining thereto.

3. Study of the process for the purpose of ascertaining opportunities for improvement through the elimination of uncertain factors; waste of effort; fatigue; waste of time resulting from faulty technique, unstandardized conditions, faulty materials, obsolete or unsuitable machinery and machine accessories, inconvenient arrangement, poor surrounding conditions or inadequate auxiliary service to workers engaged in the process.

4. Establishment, as a result of analysis, comparison and study, of equipment, tool and product standards—in short, standards applying to all the physical conditions governing performance of work — which will represent the best that can be obtained or devised, consistent with the practical and economic limitations governing at the time.

5. Obtainment of the interested and hearty cooperation of the worker through explanation of the purposes and effects of methods study and through demonstration of the beneficial objectives of this and related features of scientific management, particularly as they have a bearing upon his own welfare and interests, in order that his share in the undertaking may be most effective.

6. Study of the elements of personal skill, effort and their physical and mental effects upon the worker, as these are involved in the process, with a view to adopting as standard a method which is compatible with the worker's well-being and which embodies the collective best practice and experience of various workers in the same craft.

7. Development and adoption as standard, after analysis, study and experiment, of a method which will represent, under standard governing circumstances and conditions, the best that can be devised at the time, with due regard to quality of product, economy in utilization of material, effect upon machinery and tools, upon other indirect as well as direct cost factors, and the welfare of the worker.

8. Establishment of a task or performance standard that represents, under the standardized conditions and equipment, the time that it should take a "first-class worker" to do the work in question as indicated by properly made elementary time studies.

9. Provision of adequate means and suitable organization for the maintenance of the standardized conditions and auxiliary services upon which the attainment of performance standards depends.

It will be apparent from the foregoing that many factors involved in the problem of establishing a standard method may fall outside what we ordinarily consider the field of a time-study man, or even of a methods department. Finance, volume of sales, design, raw materials, plant equipment and its arrangement, organization, mechanisms or systems of management and industrial relations, all may have weight in deciding upon the best method and upon the worker's accomplishment. It will, I believe, also be seen that what I have stated in an attempt to formulate the principles underlying methods study, is consistent with and involves the four basic principles of scientific management as stated by Taylor. Dr. Person has recast these under the headings of Management Research, Management Standards, Management Control and Cooperation.

Quoting from my chapter on "Control of Shop Operations" in "Scientific Management in American Industry":[14]

> The control of shop operations or the planning and direction of work, as it may better be identified, comprises three major

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[14] Pp. 319-320.

> objectives: (1) predetermining what is to be done, how it is to be done, what facilities and materials are to be employed, and when it is to be done; (2) providing and bringing together at the right time the material, the facilities, the requisite information and the qualified worker; (3) providing such auxiliary assistance, service and supervision as may be essential to the successful and economical accomplishment of the work.
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> The first of these—the predetermination of what, when and how—starts with the provision of drawings, specifications, models or samples, the object of which is to show, in a manner that will preclude the possibility of error or misunderstanding, the nature of the article to be produced or the service to be performed. In many lines of manufacture, particularly in the metal trades, it has long been the practice to provide mechanical drawings, but it has only been within recent years that there has been an appreciation of the full purpose that drawings should serve and of the information they should convey—in short, of the fact that the main purpose of drawings is to answer every question that might arise as to just what is required. . . .
>
> When the basic information as to what is to be done has been provided, the next step is to determine how the work is to be done, what facilities are to be utilized, and what materials will be needed at each stage of the work. This would include what are in most instances of scientific management regarded as two distinct major functions of a properly organized planning department; namely, "routing," and the preparation of detailed instruction cards defining the manner in which individual operations are to be performed. The latter of these two functions, or stages, in the planning of work is in reality a continuation of the first.
>
> These two functions of planning call for the previous establishment of certain features of the Taylor system that are essentially preliminary and auxiliary to the functions in question. Without these, effective planning will be found difficult if not impossible. They are: (1) rearrangement of machinery or such other equipment as may be necessary to facilitate the storage of materials (jobs ahead) at the various machines or work places and its movement from operation to operation, greater independence in the use of machines and of personnel, and so on; (2) the establishment of a store room and a system for its operation or, as today few plants are found totally lacking in this respect, the development or modification of existing store rooms and systems to meet the requirements of routing and of centralized control; (3) development of the order system—including shipping orders and manufacturing orders; (4) development or modification of the balance-of-stores or stock-record system so that it may not only be a record of transactions and of what is on hand in the store rooms, but also a live agency regulating the procurement of materials and feeding work to the shop; (5) provision of suitable information relating to the product to be manufactured, in the shape of drawings or specifications, showing as a basis for routing the materials required and what is to be done; (6) standardization of machinery, tools and other facilities, and the availability in the planning department of codified data in regard thereto.

The influence of that unit of an organization which decides upon standard methods extends to all other units. It may be, as it has been in the past, the instigating force in standardization of parts and of draughting practice in engineering industry; it may and does, although sometimes in a rather crude way, influence, if not govern, the design of special machinery or even details of general purpose machines; it may be a factor in determining sales policies and the products to be manufactured.

The purpose of time study, even when thought of in its broader sense, has been too generally regarded as limited to the establishment of production standards and to the determination of a basis for an incentive wage system. This is in part due, as I have suggested, to the misplacing of emphasis in the earlier writings on the subject, and in part due to the persistence of a limited understanding of the interdependency of the various functions of management. In addition to its influence upon other branches of management and to serving what may be regarded as its primary purposes, it serves an important group of secondary purposes in the conduct of a business. These include planning and scheduling work for men and machines, estimating costs and predicting delivery dates, balancing labor forces, etc.[16] These important secondary purposes were well understood and utilized by Taylor and his associates when I joined the group in 1904.

III. Qualifications of Men to Undertake Methods Study

Just as there is need for a standard with respect to workmen whose performance is to be studied and for whom tasks are to be set, there is need for a more uniform and definite specification of the qualifications of the individuals who are to undertake methods study. In "A Piece-Rate System" Taylor makes no comments on the men who made the early studies that served as a basis for elementary rate fixing at Midvale. We know, however, that they were men of ample practical experience coupled with education above that of the average workman of that day. Taylor states that time studies of handling pig iron at Bethlehem were made by "an intelligent college man who had not before handled this class of labor, although he understood managing workmen."[16] Time study at the Simons Rolling Machine Company on the manufacture of bicycle balls was made by Sanford E. Thompson, a graduate civil engineer. Dwight V. Merrick, one of the earliest to make a profession of this branch of scientific management, combines practical experience with technical training as a background. Successful time-study or methods-study men have been drawn from the ranks of both college trained and shop trained men. In many instances it may be easier or wiser to utilize shop trained men, particularly in work of such an intricate character, or involving such trade knowledge, as to make of paramount importance the intimate familiarity that results only from years of experience as a workman. In such a case, considerable assistance and guidance from a scientifically or technically trained man may be essential. For example, a skilled machinist would benefit by the help of a mechanical engineer or an expert tool designer familiar with the purposes and technique of methods study. A mechanical engineer of limited practical experience in the trade would be successful in such a case in proportion to the degree of interested and honest co-operation he was able to secure from the workmen. In simpler industries, where operations are elementary, technical education is of more importance than actual experience in performing the operations concerned.

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[16] For detailed treatment of these uses of the results of time study I would refer you to: "Smoothing the Wrinkles from Management; Time Study the Tool" by Sanford E. Thompson, *Bulletin of the Taylor Society*, Vol. XIII, No. 3, April, 1928; "The Taylor Technique of Time Study" by Dwight V. Merrick, *Bulletin of the Taylor Society*, Vol. XIII, No. 3, June, 1928; "Planned Control" by William O. Lichtner, The Ronald Press, New York, 1921; "Balance of Work" by William D. Hemmerly, *Bulletin of the Taylor Society*, Vol. V, No. 3, June, 1920.

The temperament and personality of a "methods" man must be such as to enable him to gain the confidence and co-operation of the workers and to overcome difficulties in accomplishing his purpose without creating antagonism. Workers are most likely to trust men whom they know and who have had practical experience in their trade or occupation. Hence, where suitable candidates are available, it is best to select and train men for this function of scientific management from within a company's own organization. In a group of fifteen of the best men whom I have trained for methods-study work, eight were from the ranks of workers or foremen, and seven were college graduates. The latter included a civil engineer, two chemical engineers, one mining engineer, two mechanical engineers and one graduate of a school of business administration.

The qualifications of an ideal time-study man may be summed up as follows:

1. Mental qualities.
   a. An understanding of human nature.
   b. An analytical turn of mind.
   c. A questioning attitude toward existing knowledge and practice, coupled with a desire to prove all things.
   d. Keen perception and foresight.
   e. Open-mindedness, freedom from prejudice or disposition to jump at conclusions.
   f. Ability to concentrate.
   g. Good judgment, common sense and a sense of proportion and values.
   h. Accuracy.
2. Personality and character.
   a. Tact.
   b. Patience and self-control.
   c. Honesty and dependability.
   d. Frankness and fairness.
   e. The courage of his convictions—self-confidence.
   f. Grit, tenacity, perseverance.
3. Education and training.
   a. A general education at least equivalent to that of a high-school graduate.
   b. A sufficient knowledge of management to understand the relation of methods study to other functions.
   c. A knowledge of the rudiments of mechanical engineering, embracing mechanical drawing, physics and mathematics.
   d. An intimate knowledge of the processes of the industry in which he is engaged and skill in their performance.
4. Ability to get things done.
   a. Constructive imagination, inventiveness.
   b. Resourcefulness, ability to surmount difficulties.
   c. Ability to inspire and sustain the interest of others and to secure active co-operation.
   d. Freedom from hesitancy in deciding to start and carry through a plan of action.[17]

Needless to say, few candidates will be found ready made—possessing all or a majority of these qualifications in the desired degree. What the selected man lacks must be made up in one or both of two ways: (1) instruction and training; (2) assistance or co-operation of others possessing the qualifications that he lacks. Perhaps ability to secure and utilize effectively the knowledge and assistance of others is the most important qualification for methods study, whether in the case of the man of principal responsibility or an assistant.

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[16] *Shop Management, op. cit.*, p. 48.

[17] This is a composite statement of qualifications based upon the writings of Taylor, Gantt, Merrick, S. E. Thompson, Lichtner, Lowry, Maynard, Stegemerten and other practical men, as interpreted in the light of the author's experience.

IV. The Operator Selected for Time Study

Qualifications of Workman Co-operating with Methods Man

One of the points about which there has been most confusion relates to the skill and productive ability of the worker who co-operates with the time-study or methods man. This is equally true of the degree of skill of the worker for whom production standards or tasks should be set. The situation is somewhat clarified if we bear in mind what is too often lost sight of, that scientific management has for one of its basic principles, as stated by Taylor: "They (the management) scientifically select and then train, teach and develop the workman, whereas in the past he chose his own work and trained himself as best he could" and furthermore, as Taylor stated in the third principle, "They heartily co-operate with the men so as to assure all of the work being done in accordance with the principles of the science which has been developed."

Taylor repeatedly said that the task or standard of production should be so fixed as to represent what a *first-class* man could do. In his "A Piece-Rate System," in enumerating the advantages of the system described, Taylor said, "It automatically selects and attracts the best men for each class of work, and it develops many first-class men who would otherwise remain slow or inaccurate. . . . "[18] He speaks of ascertaining by elementary time study "the quickest time" in which work can be done. This would imply its being done by a "first-class" man. In this regard, however, he is much more specific in his classic paper "Shop Management," presented eight years later, from which the following is quoted.

> The possibility of coupling high wages with a low labor cost rests mainly upon the enormous difference between the amount of work which a first-class man can do under favorable circumstances and the work which is actually done by the average man.
>
> That there is a difference between the average and the first-class man is known to all employers, but that the first-class man can do in most cases from two to four times as much as is done by an average man is known to but few, and is fully realized only by those who have made a thorough and scientific study of the possibilities of men.
>
> The writer has found this enormous difference between the first-class and average man to exist in all of the trades and branches of labor which he has investigated, and these cover a large field, as he, together with several of his friends, has been engaged with more than usual opportunities for thirty years past in carefully and systematically studying this subject.
>
> This difference in the output of first-class and average men is as little realized by the workmen as by their employers. The first-class men know that they can do more work than the average, but they have rarely made any careful study of the matter. And the writer has over and over again found them utterly incredulous when he informed them, after close observation and study, how much they were able to do. In fact, in most cases when first told that they are able to do two or three times as much as they have done they take it as a joke and will not believe that one is in earnest.
>
> It must be distinctly understood that in referring to the possibilities of a first-class man the writer does not mean what he can do when on a spurt or when he is over-exerting himself, but *what a good man can keep up for a long term of years without injury to his health. It is a pace under which men become happier and thrive.*[19]

Even more definite, however, is Taylor's statement further on in "Shop Management":

> Perhaps the greatest difficulty rests upon the fact that no two men work at exactly the same speed. The writer has found it best to take his time observations on first-class men only, when they can be found; and these men should be timed when working at their best. Having obtained the best time of a first-class man, it is a simple matter to determine the percentage which an average man will fall short of this maximum.[20]

Dwight V. Merrick, who worked with Taylor, Barth and Gantt at Bethlehem and who has specialized on time study to a greater extent than any other man in the movement, says in his book, "Time Studies for Rate Setting," "The operator should be advisedly a first-class worker, skilled in the line of activity under investigation and of somewhat better than average ability. . ."[21] In contrast to these and other similar statements, we find writers on the subject speaking of the "average" man. In discussing a paper read before this Society, Mr. Joseph A. Piacitelli got to the root of the matter when he said, "Another point brought out is that we must time the average man or time work on the basis of average performance. That is true if we want to know how long it takes to do a job or to get an average. *But* we should be most interested in bringing the performance of the mediocre workman up to that of the skilled."[22]

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[18] P. 858.

[19] Pp. 25-26.

[20] P. 168.

[21] P. 5.

In his paper "Selection of Workers for Observation," published in the June, 1928, number of the Bulletin of the Taylor Society, Mr. Piacitelli discusses this question in a most logical and convincing manner, bringing out forcibly the fact that time studies of the work of any but "first-class" workers, and the basing of standards of performance upon mediocrity must be at variance and inconsistent with the principles and purposes of scientific management, and consequently may not be regarded as being properly representative of its practice.[23]

The confusion which one finds even in the writings of a single individual indicates the existence of two distinct and incompatible ideas. The first is the idea underlying scientific management as Taylor conceived it, i.e., that standards established as a result of methods study should represent the greatest improvement possible over what previously prevailed; and that, as "Shop Management" puts it, the standard of performance should be such that ". . . each workman should be called upon to turn out the maximum work which a *first-rate man* of his class can do and thrive (under)."[24] The acceptance of this viewpoint places upon management a definite responsibility *for so selecting, training and assisting the workers that all those assigned to a given kind of work will be "first-class" operators or may properly be expected in due time to become "first class."* In this we have a recognition and acceptance of the principles of scientific management.

The second viewpoint, which seems to reflect a hopeless, resigned and passive attitude, in contrast to a virile, progressive and constructive one, is that we must take and leave workers as we find them, that wide variations in ability of individuals, even in the performance of simple operations, are inevitable and immutable. Such may have been the case in a great measure under the old-style management but this viewpoint or belief is untenable if our object is to carry out in practice the principles of scientific management.

To be satisfied with conditions as they may exist is to select the path of least resistance and to dodge responsibility or to be negligent, if not ignorant, of opportunity.

The study of work done by "average" operators and the establishment of standards representing what would be a fair task for the "average" worker indicate an acceptance of this second viewpoint. I should say, however, in justice to those who have advanced this idea, that a desire to be fair to all operators has been behind it even though the motive may have been based on unsound social and economic premises. Some writers on the subject endeavor to fit the standard to the "average" operator by making studies of a number of operators of varying degrees of skill, from the poorest to the best inclusive, and then averaging the results, while others advocate making studies of the work of the best and then adding a percentage of time to make the standard fit the average worker.

Under a properly applied system of scientific management, with the removal of hindrances to accomplishment with which the average operator cannot cope, and with the service, assistance and encouragement given the worker by the management, there is ample evidence in most occupations that the differences in skill and ability that exist among workers under ordinary management can in a large measure be diminished. There may be and usually are in any group some operators who are unfitted for their jobs and who can never attain the ranks of the first class. In regard to these, it may be stated as an axiom that for every individual there is some work in which he or she could rank as first class, and in practice there is ordinarily no great difficulty in bringing about a satisfactory reassignment of those who have been misplaced.

Scientific management aims to make it possible for all workers to become first class and to this end it is essential that the studies serving as a base for production standards be made upon the work of a first-class operator. Otherwise we do not have a uniformly reliable means of measurement.

In their book, "Time and Motion Study and Formulas for Wage Incentives," a valuable contribution to the literature on the subject which sets forth many features of time-study technique more fully and clearly than has been done by previous authors, Messrs. Lowry, Maynard and

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[22] Discussion of "Smoothing the Wrinkles from Management: Time Study the Tool," *Bulletin of the Taylor Society,* Vol. XIII, No. 2, April, 1928, p. 84.

[23] "Selection of Workers for Observation," *Bulletin of the Taylor Society,* Vol. XIII, No. 3, June, 1928, p. 136.

[24] Pp. 28-29.

Stegemerten have undertaken a classification and grading of workers' productive ability under the headings "skill" and "effort." I regard this as the best classification I have seen to date. They also describe several methods by means of which time studies of work performed by operators falling within one class may be adjusted to represent the performance of workers who belong to another class. In regard to this the authors say, "The time-study system must be applicable to all operators good, bad or indifferent. The work must go on whether the most desirable type of operator is found or not. There must be, however, a leveling process at some stage of the work."[25]

Whether the studies are made upon an "average" man, in which case there would be no adjustment or leveling process, or upon one of higher or lower rating in the matter of skill and effort, the purpose indicated is to set rates which represent a proper task for the average man or, as the authors state, "In other words, the average will determine the plane along which the operator possessing average skill will continuously work while giving an average effort. The standard-time values for all operations in the plant should be along this plane."[26] This assumes that the man above average will or can do the work in less than the time set, while the man below average will take longer to do it. Compensation will be more or less according to the time taken. This is the opposite of what Taylor referred to as the "task idea in management," and is open to the objections that may be raised to any of what he characterized as "drifting systems." In "Shop Management" he said:

> (a) A Large Daily Task. Each man in the establishment, high or low, should daily have a clearly defined task laid out before him. This task should not in the least degree be vague nor indefinite, but should be circumscribed carefully and completely, and should not be easy to accomplish.
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> (b) Standard Conditions. Each man's task should call for a full day's work, and at the same time the workman should be given such standardized conditions and appliances as will enable him to accomplish his task with certainty.
>
> (c) High Pay for Success. He should be sure of large pay when he accomplishes his task.
>
> (d) Loss in Case of Failure. When he fails he should be sure that sooner or later he will be the loser by it.
>
> When an establishment has reached an advanced state of organization, in many cases a fifth element should be added, namely: the task should be made so difficult that it can only be accomplished by a first-class man.[27]

Now, if we attempt to combine the task idea with any plan which must apply permanently or indefinitely to all grades of workers, good, bad and indifferent, we must set tasks or standards of performance for each. This can be done by using the time of one grade as a base and increasing or diminishing the time allowed to fit the others.

In explanation of the seeming inconsistency in the last paragraph of the statement just quoted from Taylor's work, it may be said that he had in mind a progressive raising of the "average" of ability until practically all operators became "first class." Many years ago at the Tabor Manufacturing Company we established, upon his advice, ratios between the standard task time based upon time studies of elementary operations performed by a first-class man under standardized conditions and methods, and the time that a less experienced operator should be allowed. This was done with a view to being fair to newly employed operators as well as to those promoted to a higher class of work or temporarily assigned to a class of work with which they were not entirely familiar. Such extra allowances, however, were not regarded as permanent and were progressively decreased as the worker advanced in experience and skill. I discussed this subject about two years ago in a memorandum on a time-study job conducted jointly by employers and the union in the ladies' garment trade. I quote from it the following on dealing with varying productive ability in a group of operators engaged on the same kind of work:

> The variation in productive ability should be regarded as temporary and something to be corrected, and with this in mind I should, leaving the exceptional workers out of the transaction, establish several classes of workers, Class A being all of those ranked as "first class"; Class B the next lower grade, and so forth. Then for each of these classes I should determine as a result of over-all studies, comparing the actual accomplishment with the standard time, a percentage of allowance of additional time for that particular class. This might be, as it probably would, 15 or 16 per cent for Class A, 25 per cent for Class B, etc. For each of these classes I would establish a suitable base wage rate. This I have done in shops formerly working on piece work by taking the average earnings as a base wage for each class, the workers receiving additional compensation or bonus in addition thereto for every job accomplished

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[25] Lowry, Stewart M., Maynard, Harold B., Stegemerten, G. J., *Time and Motion Study and Formulas for Wage Incentives*, New York, McGraw-Hill Book Company, Inc., 1927, pp. 23-24.

[26] *Ibid*, p. 118.

[27] Pp. 63-64.

in the time set, which was the standard time plus the percentage for the class in which the operator was placed. Competent "instructors" drawn from the ranks of the "exceptional" or the "first-class" operators were assigned to assist the workers in the lower classes who were promoted as rapidly as they proved eligibility for a higher rating. We also made their pay increase retroactive upon promotion to cover all jobs accomplished in the prescribed time for the class to which they had attained. Some operators we found fell short because through overanxiety they rushed, some had developed awkward or faulty habits involving wasted motions and efforts, some lacked self-confidence and needed only a kindly word of encouragement. The number who failed to make the grade was almost nil and for these work for which they were better suited was found.[28]

In the general machine shop or a plant engaged in comparable work, the existing variation in skill or productive ability may be taken care of largely by assignment of men to work for which they are qualified. However, when a man first starts to work under the task system, temporary additions to the standard time may be desirable. Most of the reassignment or classifying of workers may, however, be accomplished long before the time to start task work has been reached.

In the past methods followed in determining the percentages temporarily to be added to the standard task time, while reasonably satisfactory in the instances concerned, have not been scientific to an adequate degree. The scheme described by Messrs. Lowry, Maynard and Stegemerten under the heading of "leveling," together with that for classifying skill and effort, strikes me as going a long way toward providing a truly scientific method for grading individual ability and determining these temporary additions to standard time. We speak of "scientific selection of workers" but, although much thought and considerable research have been devoted to the development of a technique of selecting, principally by those interested in what is termed personnel management, we must still fall back upon the best judgment afforded by experience in the matter of initial selection and upon trial under practical working conditions as a check. It is in the development of a technique that will be worthy of the term "scientific" that I think the Lowry, Maynard and Stegemerten method referred to above may present important possibilities. Such a technique should involve sensible and practical tests of workers on typical standard operations, and should permit comparison of their performance with a standard of performance worked out by studying a first-class worker on the same operations.

If it is a mistake, for the reasons I have endeavored to point out, to make time studies with an "average" worker, it would appear to be an even greater mistake to base standards of production upon average performance as indicated by time studies of a number of operators, including the good, the bad and the indifferent. My views on this were expressed in the memorandum already referred to. From this I quote the following:

> If I may be permitted to use a somewhat inelegant expression, Mr. Katofsky "said a mouthful" when he remarked: "From the viewpoint of time-study data such as must be used if the standards system is to prove fair and satisfactory there can be only two standards, namely, *accurate* or *reliable* and *inaccurate* or *unreliable*. . . . . There can be no grades in between."
>
> Here Mr. Katofsky has put his finger on the cause of most of the troubles so far experienced—and there are, I fear, more to come unless radical, corrective steps are taken. The desired improvement cannot, however, in my estimation, ever be effected so long as the present method of making studies is adhered to. I can readily understand the reasons that led to the adoption of the present basically wrong procedure and have little hope of its immediate correction, but I am convinced that eventually, in the light of experience, the plan which I shall describe will and must be adopted if enduring benefit is to result.
>
> Briefly, the principal error lies in attempting to base the standard on the production of the average worker. I should consider figures arrived at as a result of studies of work done by ten workers, supposedly including a range from the fastest to the slowest, as not being worth the time and trouble taken to accumulate them. Such studies cannot help but be inaccurate individually and their faults are increased in proportion to their number. This practice is based upon and is calculated to perpetuate an all too prevalent error to the effect that there is a wide and *permanent* difference in the skill and productive ability of different workers on the same kind of work. Or in other words, that some workers are predestined to be and remain first class, some fair to middling and others poor. Such a doctrine is revolting and I believe unsound socially and economically.
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> If my experience has taught me anything, it is that this difference diminishes in direct ratio as the quality of management improves. I recall most vividly my experience in a plant the nature of whose work was sufficiently comparable to that in the ladies' garment industry where under the old management piece-work earnings ranged, taking the earnings of the supposedly best workers as 100, down to 40, the average being around 65. In commenting on this the plant manager expressed keen regret but felt no respon-

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[28] Comment on A Report on the Production Standards Situation in the Ladies' Garment Industry of Cleveland, August, 1925.

> sibility for the state of affairs which he regarded as an incurable misfortune. The statement "some of them are good and some are poor workers" ended the matter so far as he could see. But after improving and standardizing conditions, providing adequate service to the worker and replacing the old type of "boss" supervision with functional foremanship of a type calculated to provide help when and where most needed, the force as a whole attained a productive efficiency of over 95 per cent of a standard based on studies of the work of a *first-class* operator.

By this I do not want to be understood as saying that time studies should not be made upon more than one operator in determining a standard for a given operation. Often it will be found by combining various elements from the method followed by each of several first-class workers, that a method superior to that based upon the work of the best individual may be built up. Likewise, where any question exists as to whether the operator whose work is studied is truly "first class" and has really co-operated, results should be checked by studies of other operators. It is important that time studies be made on a first-class operator not only because of his superior skill and speed but because of his ability to effectively co-operate in the undertaking. This is well expressed by Joseph A. Piacitelli, who said in his paper "Selection of Workers for Observation":

> The workers studied by the investigator employing the motion-study technique in which the late Major Frank B. Gilbreth pioneered, are selected largely on the basis of the contribution they can make toward the establishment of the best method. Usually much of the desired data is obtained from the study of the best available. By best available the worker who produces most is not necessarily meant, but the one whose method shows the greatest productivity possible, although he may not exert enough effort to realize its possibilities. In other words, the production record does not always indicate the best workers from the point of view of the methods employed by them. Invariably, however, the best workers, as indicated by their records, *do* have good methods and it is usually desirable to study them. Workers whose methods for any part of a cycle appear to be less fatiguing are also selected for the same study. The best workers available should be selected for the following reasons:
>
> 1. That they invariably employ methods of least fatigue.
> 2. That they usually have the highest degree of automaticity, thus making possible the analysis of a higher order of skill.
> 3. That the motion study-technique, making use of the motion-picture film and clock, permits a minute analysis of the method and performance.
> 4. That the technique permits a more detailed description of the established method (that is, in elements of motion) and shortens the learning period.
> 5. That the composite best method can be more easily transferred, making a higher performance standard attainable by all normal workers. . . .
>
> Aside from the qualities already mentioned the worker selected for observation, regardless of the technique employed by the observer, should preferably be one with ability to learn and demonstrate new methods; one who is not disliked by his fellow workers and who will serve as nearly as possible as a co-investigator.
>
> It is the opinion of the writer that the analysis of the performance of the best workers available, from the standpoint of method and economy of effort, and the transference of their combined skill contribute most toward elevating the performance standard of the department as a whole, and this, of course, is desirable from the point of view of lower cost and higher wages. We have both the *intellectual* and physical equipment to increase the effectiveness of our productive efforts and should make the most of our opportunity to practice, and benefit therefrom, the three regulative principles of industrial management ably stated by Church and Alford as, "the systematic use of experience"; "the economic control of effort" and "the promotion of personal effectiveness." The greatest progress can be made by utilizing, to the best advantage, the facts derived from the study of leaders in their respective activities, whether the activities are carried on in the office or in the shop; in the store, or in the bank.[29]

Another leading authority in this field, William O. Lichtner, says in his book, "Time Study and Job Analysis":

> Although due consideration must be given to the relative importance of quality and quantity on the operation, one thing may be said definitely—the studies should be made on an employee who is skilled. This is advisable for the following reasons:
>
> 1. His motions are more uniform.
> 2. He works more steadily.
> 3. He is apt to use the best methods and to adapt himself more easily to new ones.
> 4. The influence of the personal equation is less pronounced.
> 5. The results manifest his fluctuations and are more dependable.
>
> The erratic work of the unskilled employee throws all manner of unnecessary variables into the detailed unit times. It will be necessary to determine whether the variation in the time taken by an element is due simply to the fact that the employee is unskilled, or is due in part to the material he is working upon or the tools he is using. Under these conditions it will require more studies and a greater degree of skill on the part of the analyst to determine the correct times accurately.
>
> In group work, since the speed is limited by the speed of its slowest members, the personnel of the group must be considered to see whether it is composed of skilled employees, and if not, whether such a group can be brought together.[30]

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[29] "Selection of Workers for Observation," *op. cit.*, p. 138.

[30] Pp. 154-155.

In speaking of the "average" man, it would appear that many have in mind one who is considerably above the general average found in the average shop. For example, Sanford E. Thompson states in one of his papers: "In the fixing of standards of performance, the workmen observed must be adapted to a degree representative of the average of the *best* group of workers available in the particular locality."[31]

Obviously there is a world of difference between an "average of the best" and an average of good, bad and indifferent. This is further illustrated by Hugo Diemer's discussion at the spring meeting of the Taylor Society in 1928:

> Where a number of such workers is available a process of selection and elimination can be carried to a considerable extent through the medium of consultation of employment records and conferences with foremen. In this process of selection and elimination, it is not necessary to establish any numerical rating scales. A plus or minus sign opposite each of the following qualifications will be entirely sufficient. Important qualifications in the matter of selection are: (1) physical adaptation and dexterity, (2) intelligence, (3) speed, (4) accuracy, (5) temperament, (6) attitude.
>
> *Naturally that worker will be most desirable* who *rates plus in each of these six qualifications. . . .*
>
> The "average experienced operator" is a desirable subject for time study. Experts are not common and speeding up an operator's rate of performance for the purpose of time study is not practicable. Therefore, the worker to be selected should be of average intelligence, speed, accuracy and dexterity, and normal as to temperament, attitude and physical adaptation. *It is often difficult to find even these requirements in certain groups of employes.*
>
> Selecting the workers for observation, then, is important, and by proper consideration of this element of time-study technique, much can be gained.[32]

I am inclined to believe that what Mr. Diemer here speaks of as an "average experienced operator" would be much the same as Taylor's "first-class" man.

I hope I may have made it clear that if our object is to carry out in practice the principles of scientific management, it is just as important for the establishment of production standards that the performance of the operation be "first class" as it is that the machinery, tools and other governing conditions conform to a high standard. Hence, our aim should be to study the work of first-class operators only. There is need, however, for a clearer definition of the term "first class." My own definition of a "first-class" operator is one who is not exceptional or what in shop parlance is known as a "speed king." He is what Taylor taught me to understand by the expression, i.e., a steady, intelligent and conscientious worker who is skilled in the trade, produces good work and whose performance under proper conditions and instruction may reasonably be expected to be attained and kept up without detriment to the well-being of anyone physically, intellectually and temperamentally suited to the work. This, I think, may be made more specific by a utilization of the plan of evaluation set forth by Messrs. Lowry, Maynard and Stegemerten, who class "skill" and "effort" under the following grades:

Super Skill	Killing Effort
Excellent Skill	Excellent Effort
Good Skill	Good Effort
Average Skill	Average Effort
Fair Skill	Fair Effort
Poor Skill	Poor Effort

Using their excellent definitions of these classes, I should say that Taylor's "first-class" man or Mrs. Lillian M. Gilbreth's "standard" man, referred to in her "The Psychology of Management," would fall in between the classes "excellent" and "good" in the matter of skill, and the same would be true in regard to those attributes listed under "effort." "Good skill" and "excellent skill" are summarized by these authors as follows:

Good Skill: (S G)

1. Noticeably better than ordinary run of men.
2. Markedly intelligent.
3. Possesses good reasoning ability.
4. Responds readily to suggestions.
5. Needs little supervision.
6. Uses machine or tools to good advantage.
7. Fairly quick in motions.
8. Works correctly to specifications.
9. Can instruct others less skilled.
10. Possesses originality.

Excellent Skill: (S E)

1. Precision of action.
2. Shows speed and smoothnesss in performance.
3. Thoroughly familiar with work.
4. Makes no mistakes.
5. Works accurately with little measuring or checking.
6. Operates his machine or tools to best advantage.
7. Can think out best methods for doing work.

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[31] Thompson, S. E., "Smoothing the Wrinkles from Management: Time Study the Tool," *Bulletin of the Taylor Society*, Vol. XIII, No. 2, April, 1928, p. 78.

[32] Diemer, Hugo, Discussion of "Methods of Observations," *Bulletin of the Taylor Society*, Vol. XIII, No. 3, June, 1928, p. 144.

8. Makes speed without sacrificing quality.
9. Has full self-confidence.
10. Designs labor-saving tools.

"Good effort" and "excellent effort" are summarized as follows by Messrs. Lowry, Maynard and Stegemerten:

Good Effort: (E G)

1. Little or no lost time.
2. Takes an interest in the work.
3. Takes no notice of time-study man.
4. Works at best pace suited for endurance.
5. Follows a set sequence.
6. Conscientious about his work.
7. Has faith in time-study man.
8. Encourages advice and suggestions and makes suggestions.
9. Well prepared for job and has work-place in good order.
10. Steady and reliable.

Excellent Effort: (E E)

1. Works fast.
2. Uses head as well as hands.
3. Takes keen interest in work.
4. Receives and makes many suggestions.
5. Reduces false motions to a minimum.
6. Works systematically to best of his ability.
7. Has utmost confidence in time-study man.
8. Cannot keep up effort more than a few days.
9. Endeavors to show superiority.
10. Uses best equipment and methods available.[33]

A study of these will show that many of them coincide with or complement the qualities classified under "skill."

In rating a first-class man as to skill and effort, using these summaries of qualifications, I should select from the two tables:

1. *General Character and Experience*

a. In all respects noticeably better than the ordinary run of men. (SG 1)

b. Thoroughly familiar with the work. (SE 3)

c. Conscientious about his work. (EG 6)

d. Steady and reliable. (EG 10)

2. *Performance*

a. Shows speed and smoothness in performance. (SE 2)

b. Works accurately with little measuring or checking. (SE 5)

c. Uses machine or tools to good advantage. (SG 6)

d. Works at best pace suited to endurance. (EG 4)

3. *Intelligence*

a. Markedly intelligent. (SG 2)

b. Good reasoning ability. (SG 3)

c. Possesses originality. (SG 10)

d. Uses head as well as hands. (EE 2)

4. *Quality of Workmanship*

a. Can work correctly to specifications. (SG 8)

b. Makes speed without sacrifice of quality. (SE 8)

5. *Co-operation*

a. Encourages advice and suggestions and makes suggestions. (EG 8) Responds readily to suggestions. (SG 3)

b. Takes an interest in the work. (SG 2)

c. Reduces false motions to a minimum. (EE 5)

d. Has faith in time-study man. (EG 7)

6. *Initiative*

a. Needs little supervision. (SG 5)

b. Has full self-confidence. (SE 9)

c. Uses best equipment and methods available. (EG 9)

7. *Orderliness*

a. Works systematically to best of his ability (EE 6); follows a set sequence.

b. Well prepared for job and has work-place in good order. (EG 9)

It must be borne in mind that establishing and maintaining hearty co-operation between the management and the workers constitutes one of the principles of scientific management as stated by Taylor. This applies in a most direct way to methods study and the establishment of production standards. To cite an example of workers' co-operation in methods study, in the plant of one of my clients, a number of large looms were operated in the production of a closely woven fabric from a coarse yarn known in the trade as "camel hair." The actual production of these looms as they had been operated represented about 60 per cent of a theoretical maximum, assuming that they might run continuously. Our studies showed the non-weaving time to be made up principally of two things:

1. The necessary operation of changing bobbins in the shuttle which occurred every three minutes and consumed on the average 1.25 minutes or 29 per cent of the effective operating time. As a result of improvement and standardization of physical conditions, the time for this operation was reduced to about half. At this point the interest of several of the best weavers was aroused and with their co-operation a composite method embodying elements of the methods of each was built

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[33] *Time and Motion Study and Formulas for Wage Incentives, op. cit.,* pp. 91-92.

up and the time required for performing the operation reduced to .28 minute.

2. Repairing what were commonly called "breaks" in strands of yarn composing the warp. This was not only time consuming but vexatious. Investigation showed that this was not in fact due to yarn breaking so much as to the loosening of knots where ends of two lengths had been tied with an ordinary weaver's knot. Various kinds of knots were tried without success. Finally, at the suggestion of a weaver, the expedient of tying in a short length of cotton yarn between the two ends of "camel hair" yarn was resorted to with the result that "breaks" practically disappeared. Not satisfied with this, however, weavers continued to experiment with different ways of tying one end of "camel hair" yarn to another until one of them devised a knot that would not come untied.

Production on these looms was increased from 60 per cent to about 90 per cent and at least half of the improvement was attributable to the workers' co-operation.

V. On Making Observations

Apparatus and Analysis

Almost every writer on the subject has called attention to misunderstandings of the term "time study" and the crimes that have been committed in its name. My colleague in Japan, Mr. Yoiti Ueno, told me at one time of an extreme case he had just encountered in the plant of a new client who, up to that point, had been proceeding "without benefit of counsel." The manager of this plant told Mr. Ueno that they had been making time studies. When asked how they went about it, he stated that in each department there had been placed a large electric clock which enabled the foreman to learn how long it took to perform any operation.

Gantt's comment in 1908 covers this very well. He said: "Inasmuch as, after a satisfactory method has been established, a large proportion of the work of the task setter is the study of the time in which operations can be performed, he is popularly known as the *time-study* man. This term has led to a misconception of his duties and has caused many honest people to claim that they were putting in our methods when they have put a stop watch in the hands of a bright clerk and told him to find out how quickly the best men were doing certain work. . . . Stop-watch observations on work done inefficiently, or with ill-adapted appliances, or by poor methods, is absurd and serves only to bring into disrepute all work in which the stop watch is used. Moreover, such use of the stop watch justly excites the contempt and opposition of the workman."[34]

The actual making of time-study observations has been so fully covered by others that I shall not go into it at length. Taylor devoted several pages to it in "Shop Management," Dwight V. Merrick, William O. Lichtner, Richard H. Lansburgh and Messrs. Lowry, Maynard and Stegemerten all give, in their respective books, excellent descriptions of how observations should be made and recorded, as well as descriptions of the implements and forms used.

Taylor was never satisfied with the stop watch or existing printed forms as the best implements. I recall his having frequently expressed the hope and belief that someone would invent a time-study machine that would be better. It was in response to this that Frank B. Gilbreth developed the use of the motion-picture camera and Henry H. Williams evolved a machine on which a pen records on a moving band of paper, measured off to correspond with units of time, the duration of each element of a cycle. I shall not at this time undertake a discussion of the relative merits of various devices. I believe, however, that more consideration should be given to the circumstances under which each may most advantageously be used. Some may be disposed to advocate the use of the stop watch because of its convenience and because it is the least expensive implement, or because they are familiar with it through long use and have not taken the trouble to acquaint themselves with the development and the merits of others. It would help if those who are successfully using time-measuring devices other than the stop watch would present to the Taylor Society papers based upon, and giving practical examples of, their experience.

Some years ago there came to my attention another device developed by a French engineer. It had been designed primarily to afford the advantage of recording, without subtraction, the time taken by each elementary operation in a sequence and at the same time to utilize the ordinary commercial stop watch, in which the hand is started by the first pressure on the stem, stopped by the second and returned to zero by the third. Three watches were mounted on the time-study board with a device for depressing the stem of all watches simultaneously. The first pressure started Watch No. 1 from zero; the second stopped Watch No. 1, recorded the time of the element just concluded and started Watch No. 2 from zero; the third stopped Watch No. 2, returned Watch No. 1 to zero and started Watch No. 3 from zero. The next pressure started Watch No. 1 again, and so on. Each watch thus successively recorded the time for an element while another ran during the time consumed by the succeeding elementary operation. At the time I could see no advantage over the prevailing practice of reading and recording times from a continuously running watch, except that it recorded actual elapsed times without the necessity of securing them by a subtraction at the conclusion of a study. Apart from saving the trouble of computation, it might be helpful to the man making the study by making irregularity more evident at the time. It should also in some degree reduce inaccuracy and facilitate the recording of short elements, although it is doubtful how helpful it would be in recording small elements where the average of several successive elements was three-hundredths of a minute or less. The device mentioned lacked a means of stopping all three watches at a given point in case of an interruption. This, however, could easily be provided.

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[34] "Training Workmen in Habits of Industry and Co-operation," *op. cit.*, p. 1043.

While I was in France, Mr. C. B. Thompson told me of an improvement that he had made in the standard time-study watch as developed by Colonel Sanford E. Thompson. This consists of fitting the watch with a double, or split, hand as is done with the type of watch used for timing horse races.

When the watch is started from zero, one-half of the hand remains stationary while the other half goes on. At the completion of an element the stem is pressed and the stationary hand jumps forward and stops at the place on the dial that marks the time of completion of the first element, while the moving hand continues. This is repeated in the case of each element. There is, of course, a considerable advantage in making readings from a stationary hand. One feature of the original time-study watch has been sacrificed, i.e., the ability to stop the watch at any given point and start it again from that point. An expert time-study man would almost invariably record delays rather than stop and start his watch, so that this is not an important omission.

Undoubtedly all of the measuring devices mentioned, as well as others with which I may not be familiar, have merits which, under appropriate circumstances, would make their use preferable to the old stop watch. Here is an opportunity for an impartial investigation which might be combined with, or incidental to, other research in the field of methods study.

One point that should be settled is whether we should use decimal divisions and sub-divisions of an hour or decimal divisions of a minute as the time unit. Ultimately, as greater interchange of data and experience comes about, this question will take on more importance than is attached to it at present. About 1905 Merrick, for a time, changed over to the use of a watch marked off in decimal parts of an hour. His only reason, as I recall it, was that it enabled him to compute the task time for jobs directly in hours and decimals thereof, in conformity with the time-keeping and pay system and eliminated the necessity of dividing the time in minutes by sixty. He shortly after went back to minutes and decimals of minutes and has, I believe, used this system ever since. S. E. Thompson and W. O. Lichtner use minutes and decimals thereof, as do a great majority of the leading practitioners. The only real advantage that I can see in using a watch marked off in decimal parts of an hour is that it may permit slightly finer direct readings because the hand makes one revolution in one one-hundredth of an hour, instead of in one-sixtieth of an hour, as in the case of a minute-decimal watch. The advantage of this, however, is problematical. Where elementary operations are so short as to make readings finer than .01 minute desirable, and where the system developed by Barth for the observation of two or more elementary operations together would not be satisfactory, I believe the use of some measuring device other than the stop watch should be considered. I have utilized with excellent results studies made by the Barth method mentioned above. In these the complete operation, composed of twelve elements, required only one-tenth of a minute to perform. By this expedient we obtained, with comparatively few studies, elementary unit times applicable to a great variety of jobs. It was not so satisfactory, however, as direct readings might have been. The following quotation from "Shop Management"[35] describes the Barth method:

> The writer has found that when some jobs are divided into their proper elements, certain of these elementary operations are so very small in time that it is difficult, if not impossible, to obtain accurate readings on the watch. In such cases, where the work consists of recurring cycles of elementary operations, that is, where a series of elementary operations is repeated over and over again, it is possible to take sets of observations on two or more of the successive elementary operations which occur in regular order, and from the times thus obtained to calculate the time of each element. . . .
>
> If we take a cycle consisting of five (5) elementary operations, a, b, c, d, e, and let observations be taken on three of them at a time, we have the equations:
>
> $$\begin{aligned} a + b + c &= A \\ b + c + d &= B \\ c + d + e &= C \\ d + e + a &= D \\ e + a + b &= E \\ A + B + C + D + E &= S. \end{aligned}$$
>
> We may solve and obtain:
>
> $$\begin{aligned} a &= A + D - 1/3S \\ b &= B + E - 1/3S \\ c &= C + A - 1/3S \\ d &= D + B - 1/3S \\ e &= E + C - 1/3S \end{aligned}$$
>
> The writer was surprised to find, however, that while in some cases these equations were readily solved, in others they were impossible of solution. My friend, Mr. Carl G. Barth, when the matter was referred to him, soon developed the fact that the number of elements of a cycle which may be observed together is subject to a mathematical law, which is expressed by him as follows:
>
> *The number of successive elements observed together must be prime to the total number of elements in the cycle.*
>
> Namely, the number of elements in any set must contain no factors; that is, must be divisible by no numbers which are contained in the total number of elements. The following table is, therefore, calculated by Mr. Barth, showing how many operations may be observed together in various cases. The last column gives the number of observations in a set which will lead to the determination of the results with the minimum of labor.

No. of Operations in the Cycle	*No. of Operations that may be observed together*	*No. observed together that leads to a minimum of labor or is otherwise preferable*
3	2	2
4	3	3
5	2, 3, or 4	3 or 4
6	5	5
7	2, 3, 4, 5, or 6	4 or 6
8	3, 5, or 7	5 or 7
9	2, 4, 5, 7, or 8	5 or 8
10	3, 7, or 9	7 or 9
11	2, 3, 4, 5, 6, 7, 8, 9, or 10	5 or 10
12	5, 7, or 11	7 or 11

The other advantage claimed for hour decimals has to do solely with calculation of task time. If this were the only purpose of time-study data, the advantage might be considered important. We must not lose sight of the fact, however, that workers are accustomed to thinking of most of the things they do in terms of minutes. As experience has shown, it is important that they be able to check their performance piece by piece on short jobs, or at successive stages on long jobs. Their own time pieces read in hours and minutes and for this reason the instruction card should show items or suboperations in minutes and task time for the entire lot, or job, in hours. Conversion of minutes and decimals thereof into hours is so simple a calculation that it is not a consideration of primary importance. At most it need only be done for each job as it is planned and may be facilitated by the use of slide rules, or preferably by conversion tables. Where work is put through either a number of times at intervals, or continuously, it is common practice to show on the instruction card the time for customary quantities.

Another disadvantage of using decimals of hours is that it requires four decimal places instead of two. This I should not consider serious, however, if other things were equal. In view of the foregoing the minute decimal measurement seems preferable.

One of the commonest faults of time study is the failure to break an operation down into sufficiently fine divisions. A critical study of even the best published illustrations of actual time studies shows that too often several true elements are combined as one for observation. For example, "Get stud from table and place in chuck" is given as one unit. Obviously this is composed of two distinct elements: (1) pick up piece; (2) place in chuck. The next item of this study reads: "Tighten chuck with socket wrench" which might better be stated as four elements: (1) pick up socket wrench; (2) place socket wrench in position to tighten; (3) tighten; (4) return wrench to tool stand.

In another study for machine molding I find as a unit: "Strike off and put cope board in place" which includes three elements: (1) pick up cope board from table at left; (2) strike off cope with edge of board; (3) place cope board in position.

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[35] *Shop Management, op. cit.*, pp. 172-174.

The examples given by Taylor in "Shop Management" show an inconsistency in this respect which is understandable considering the then newness of the art, but which ought not to exist in present-day practice.

As is well known to the experienced, it is difficult to record directly a number of successive elements each of which requires less than .03 minute to perform. In other words, if the time consumed in doing an element is less than the time it takes to write the figures, we must either resort to some means other than pencil and paper for recording or else use the Barth method. To this difficulty may be attributed the tendency to lump together two or more true elements in one observed unit. At this point I should state, however, that in writing instruction cards and setting tasks there is no objection to combining, within reason, several elements which are always performed in the same combination, such as those cited or, for further example, the following: "Put drill and sleeve in spindle"; "Put clamp on work and tighten." We need a term to distinguish such combinations from simple elements. For this purpose I suggest the word "group."

It may safely be stated that the more nearly work to be studied is resolved into true elements, the greater will be the accuracy of the resultant time units, the more readily will irregularities and their causes be detected and the more extensive will be the uses for the results of the studies. For example, if we should observe as a single unit "Put bushing (of a given size) in chuck (on an engine lathe) and set to run true," we should have a time unit that, strictly speaking, might properly be used only in setting a bushing of the size and kind in question in the kind of chuck used and on that particular engine lathe. On the other hand, if this operation were resolved into its true elements we should have data on handling a piece of material of the class and weight to which the bushing belonged, on the use of a wrench of the kind and size used, on stopping and starting the machine, all of which would be applicable to other operations. Picking up and placing the bushing would apply regardless of the chuck used or the machine in which the job was done. Adjusting and tightening the chuck jaws, within certain limits, would apply to the use of the size and kind of chuck, regardless of the dimensions or character of the piece. Starting and stopping the machine to see to what extent the bushing was running out of true would be the same, for the speed in question, on any job, whether that of centering work, cutting, filing or polishing. Placing the implement used for gauging the degree of eccentricity would be the same for any job on which it might be used.

Irregularity in the time required to set the pieces and its causes would be obscured if we treated the complete procedure as the unit being observed. In one observation it might occur in one elementary operation and subsequently in others, and yet the times for the cycle might be reasonably uniform and hence regarded as satisfactory.

The objections to "over-all" time studies of complete jobs or operations are today quite generally recognized and understood. It does not seem to be generally realized, however, that the same objections hold good, though in a diminishing degree, in the timing of suboperations or groups composed of several elements as though they were single units.

It is, of course, impossible to perform a single element repeatedly. For example, if we are to study the picking up of an object, and it is necessary to have a number of observations, each piece must not only be picked up but must be placed somewhere, in order that the next piece may be picked up. For this reason, as well as for the purpose of obtaining uniform smoothness of action, we must observe a number of elements arranged in a natural sequence, as for example: "Start machine and stop machine"; "Pick up scissors, cut material; put down scissors, etc."

Study of Isolated Cycles versus Complete Operations

While, as I have stated, it is impractical to make time studies of individual elements singly, it is highly desirable that the individual unit or elementary time be "net." That is to say, it should not include such things as are covered by the rather loose term "percentage of allowance." Leaving out of consideration any such allowance for fatigue, personal needs of the operator and unforeseen delays, it will be found that a "first-class" operator working efficiently on, say, fifty different elementary operations will consume a longer time than the sum of the standard unit times. The ratio of the sum of the unit times to the total time required to perform an operation varies, as Taylor pointed out, with the number of different elementary operations and the frequency of their repetition. Consequently, if the time for elementary operations is determined by timing them as they occur in the performance of complete productive operations, the unit times so arrived at will exceed what I have spoken of as "net" times, in varying degree according to the length and complexity of the job and the number of times it is repeated. I shall discuss this further under the heading of "allowances."

From the beginning, Taylor had in mind analysis of jobs into their elements. He ascertained the time required to perform each element and classified and tabulated elementary time units so that the time for other and quite different jobs might be synthetically computed in advance of their performance. Up to 1906 the method followed was to make studies of complete jobs or portions thereof and to record the time for each elementary operation or group of elements as it occurred. For the purpose of making studies in this manner, the large time-study observation sheet was devised. Taylor was never satisfied with this method on account of its slowness, uncertainty and inaccuracy. Under it, years might be consumed in accumulating, in a general machine shop, foundry or similar plant, the complete data that would make possible the setting of tasks in advance for any and all jobs that might come along. It was time study of simple repetitive operations that pointed the way to a better practice which, however, is too little known and followed today.

To avoid inadvertent inclusion of anything in the nature of "allowance" in a base or standard unit time, time studies should be made of small groups or cycles of elements which, with relatively little practice, a worker will perform almost automatically with uniformity of motions and speed. Many simple, short repetitive operations, such as one finds in the manufacture of handkerchiefs, paper boxes or in a book-binding plant, may quite properly be studied as a whole.

It was not realized or appreciated until about 1906 when Dwight V. Merrick hit upon a satisfactory solution to the problem at the Link Belt Company's plant in Philadelphia, that in more complicated work groups of elements could be isolated and studied independently. For example, in a machine shop we could isolate and study independently the various suboperations incidental to the handling of each machine, the use of small tools and the handling of materials to be worked. As a result of this plan, time studies made in one shop may be used in any other shop having the same machine and tool equipment, although the nature of its product and operations may be quite different. In this way the same advantageous condition that exists in simple repetitive work is set up.

In a large, well-managed foundry in Japan I found the management keenly interested in improving methods and setting accurate piece rates. They had started making time studies after carefully studying various books on the subject, and had a pretty good understanding of how observations should be made. They were, nevertheless, laboring under the misapprehension that they could only set rates based on time study for the simpler castings ordered in large lots, and that they must in those cases make time studies on a part of such an order in order to arrive at a rate for the balance of the lot and for any repeat orders that might be received. It was like opening up a whole new world to them when I explained that they should study not the making of complete molds from a given pattern but the independent elementary operations for each class of molding, such as placing pattern boards, placing and locating pattern, placing flasks, filling riddle, riddling facing, shoveling sand, ramming sand, placing bottom boards, putting on clamps, rolling mold over, drawing patterns, etc., etc.

In another large plant I found that quite creditable studies had been made, improved methods established and rates set for many simple repetitive operations composed of relatively few elements which were, in a great measure, peculiar to the specific jobs. Almost nothing had been done, however, in the way of time and methods study in their large general machine shop, mainly because of the mistaken belief that time studies must be made of performance of the specific job to which a rate was to apply. It was a revelation to them when I explained the practice followed in a comparable shop in America.

One does not have to look far in America to find the same mistaken belief that I encountered in the two Japanese plants mentioned, and it is because of the persistence of the idea that time studies must be made of *jobs* that American industry falls far short of realizing the full value of elementary time study.

This is a result of their failure to grasp the principal purpose of elementary time study as far as setting rates or tasks is concerned. As Gantt stated in his paper, "A Bonus System for Rewarding Labor": "When we realize . . . that any operation, no matter how complicated, can be resolved into a series of simple operations, we have grasped the key to the solution of many problems." Gantt might have added that any job done, for example, in an engine lathe is made up of a comparatively small number of such "simple" operations or groups of elements and that, from this comparatively small number of "simple operations," we may build up, by combining them in various ways, an infinite number of jobs or operations, of various lengths and complexity. The same elements and groups of elements occur over and over again in a great variety of jobs done in the same machine, and many of them may apply to work done in a number of quite different machines. This is comparable to the combination of the twenty-six letters of the alphabet into thousands of words and the combination of words to express an infinite number of thoughts, or to the combination of a limited variety of chemical elements in various molecular formations into an unlimited number of materials.

In the case of machine tools, analysis will show that, with the exception of actual cutting, these groups of elements or suboperations naturally fall into the following major classes: (1) manipulation of the machine, or machine handling; (2) manipulation of implements or small tools, or tool handling; (3) handling of materials.

To accumulate the data necessary to set a standard time for any and all jobs, regardless of whether they have ever been done before or may ever be done again, each machine in turn, after being put in standard condition, is taken out of production and turned over to the methods man and a first-class operator. A list of all of the small operations that might occur in performing various jobs on this machine is made up and classified. These small isolated operations are then resolved into their elements and a standard method for performing each settled upon, after which the "first-class" operator performs each in turn as many times as is necessary to the establishment of satisfactory unit times for the cycle and its elements. It is needless to say that for different machines a different operator might be assigned as the methods man's team mate.

The following examples of suboperations or machine-handling cycles, drawn from Merrick's book, "Time Studies for Rate Setting,"[26] will illustrate the foregoing. They relate to a 42-inch Gisholt Boring Mill.

START MOTOR

	TIME IN MINUTES
Walk to controller	.05
Start motor by controller	.06
	.11

STOP MOTOR

Walk to controller	.05
Stop motor by controller	.03
	.08

CHANGE FEED GEARS

Walk to feed gear box	.05
Change position of lever	.07
Return to operating position	.03
	.15

MANIPULATE TURRET HEAD

Loosen clamping lever	.03
Revolve and set turret	.94
Tighten clamping lever	.03
	1.00

MANIPULATE RAM HEAD BY HAND FOR 30" MACHINE

Procure crank from tool stand	.04
Place crank on screw	.02
Move head in or out (see table for various distances)	
Remove crank and replace on tool stand	.05
	.11

From the above examples it will be understood that a complicated job of machine work, or the operation of a complicated machine tool, consists of quite simple suboperations. Similarly, the handling of the small tools or implements used may be studied independently. The same tools not only may be used on a variety of jobs done in a given machine but may also be used in connection with work in several different machines. After all small tools have been standardized and classified, the procedure is to take one kind after another and make studies of the entire list. From Merrick's book[27] I draw the following illustration:

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[26] P. 122.

[27] P. 113.

SETTING ROUGHING TOOL FOR 30" MACHINE

	TIME IN MINUTES
Obtain tool and wrench from tool stand	.06
Put tool in tool post	.04
Tighten Set Screw	.14
Remove wrench to stand	.035
	.28

The handling of materials or elementary operations identified with the materials worked on, seems at first to offer more difficulty, owing to variations and peculiarities of shape, weight and size, than do machines or implements used. However, if, as a preliminary step, we work up a classification and make studies of lifting and placing materials that may be handled without mechanical aid and of those that require such aid, the problem proves to be less complicated than when regarded as a whole. This is particularly true if time studies of this subdivision of work have been preceded by studies of moving materials to and from machines, workplaces or material storage stations, and their placement with a view to convenience when performing productive operations.

Here again, as in the case of machine operations, it will be found that much of the work thought of as "handling materials" is really the utilization of facilities; for example, lifting and moving to position with a crane or hoist; putting on and taking off slings, tongs or other means of holding work while being lifted and moved. Not only does this procedure save time and expense but through it we are enabled to set accurate production standards for what are classed as "job-shops," such as the repair shops of a steel mill or one building special machinery to order.

I know that I shall be criticized, as in the past, for drawing on the machine shop for the foregoing illustrations of study of detached cycles of elementary operations. It is, however, almost impossible to find concrete examples of operations or processes with which those engaged in all lines of manufacture will be familiar. Nevertheless, I feel sure that anyone whose interest in the subject is a practical one can, from what I have said, together with what others have written, not only understand what it is all about but translate illustrations drawn from one class of manufacture into terms of his own, if he will only take the time and trouble to do so. But let us take an example with which everyone will be familiar. Suppose we want to set tasks for mopping floors of the office type with a standard mop and pail where standardized conditions prevail. This would consist of:

1. Procure mop and bucket from place stored.
2. Go to hydrant.
3. Place bucket under hydrant.
4. Turn on water.
5. Wait for bucket to fill.
6. Turn off water.
7. Pick up mop and place in bucket.
8. Pick up filled bucket and mop.
9. Walk to the floor to be mopped.
10. Place bucket.
11. Wring out excess moisture from mop.
12. Mop X square feet.
13. Return mop to bucket.
14. Rinse mop.
15. Shift bucket.
16. Repeat items 11 to 15 Y times.
17. Pick up bucket.
18. Take bucket to hydrant.
19. Empty bucket.
20. Repeat items 3 to 8 inclusive.
21. Walk to floor.
22. Repeat items 10 to 21 Z times, that is to say, until the job is finished.
23. Repeat items 17, 18 and 19 at finish of job.
24. Pick up empty bucket.
25. Return mop and bucket to storage place.

Items 1, 2 and 3 and 24 and 25, procuring and putting away tools, are one cycle which might be studied independently. Items 4, 5, 6, 7 and 19, filling and emptying bucket, may be performed and studied as an independent cycle. Items 9, 10, 17 and 18 may be studied together. The time for walking a unit of distance, independent of getting under way and coming to a stop, is incidentally determined. Items 11 and 14 constitute another independent cycle covering rinsing and wringing out. Thus, with four studies, we have the elementary time necessary for setting performance standards for any job of mopping in any building in any country where similar conditions prevail, with the exception of item 11, which would have to be studied for various kinds and conditions of floors. The foregoing, of course, covers only what might be classed as plain mopping. What an expert might class as fancy mopping would involve further research.

It will also be seen by the discerning eye that from these studies we would have some of the unit times for a number of other operations involving the use of a bucket of water.

Much time is still being lost by studying operations rather than isolated groups of the elements of which they are made up. It is urged that those engaged in methods study, even in repetitive industries, may profitably give more consideration to the study of isolated groups of elements and to methods for their classification and tabulation. In this we have a concrete, if limited, example of the need for a mental revolution which Taylor said was essential to an effective application of scientific management, of which methods study is such an important part. It is by this means that sooner or later the hope expressed by Taylor in 1895, in "A Piece-Rate System," may be realized. He said at that time:

> Practically the greatest need felt in an establishment wishing to start a rate-fixing department is the lack of data as to the proper rate of speed at which work should be done. There are hundreds of operations which are common to most large establishments; yet each concern studies the speed problem for itself, and days of labor are wasted in what should be settled once for all, and recorded in a form which is available to all manufacturers.
>
> What is needed is a hand-book on the speed with which work can be done, similar to the elementary engineering handbooks. And the writer ventures to predict that such a book will before long be forthcoming. Such a book should describe the best method of making, recording, tabulating and indexing time observations, since much time and effort are wasted by the adoption of inferior methods.[38]

In this there is need for adequately financed and well-directed practical, co-operative effort by, or on behalf of, various industrial groups.

Classification and Tabulation of Data

The usefulness of time-study data is largely dependent upon their being readily accessible when wanted. The more complicated the industry, the more important this becomes. In the case of a company which manufactured a single product in large quantities, of a single grade and size, put up in only one kind and size of unit, as, for example, twine for harvesting machines, the classification and tabulation of data would present no problem. In such a case, all material would pass through identically the same fixed series of operations. Each one would be performed by a number of identical machines and appliances under identical conditions. Hence we might file our data quite satisfactorily under the operations to which they pertained or according to the machine or work-place classifications utilized in the performance of the operations. The latter course would probably be best, as changes and improvements might gradually take place in the equipment. The next step up the scale is in industries employing single-purpose machines or work-places which, although they perform the same kinds of operations, may work on products varying in size, shape and details of construction and use certain implements which are also employed in work of a quite different character.

As an example of this, let us take the winding of small magnet coils more or less similar to those used for electric bells. A number of these are wound at one time on a paper core or "stick." They may vary in three dimensions—length, outside diameter and bore. The size and kind of wire for different coils may vary as may the number of "turns" or layers of wire and the sheets of paper fed in between certain layers. The permutations of these variables make the possible number of different coils very large. In such a case it would obviously be undesirable to make time studies of the winding of each kind and size of coil. As in the case of machine-shop work, winding any coil to its capacity on a machine such as I have in mind consists of four different kinds of elementary operations: (1) adjusting and manipulating machines; (2) using implements; (3) handling materials; (4) machine running time. Under the first heading we have operations, such as: (a) starting and stopping machine; (b) adjusting tension for various sizes of wire; (c) adjusting holders for spools of wire; (d) changing speed of machine; (e) setting counter, etc. Some of these are constant for any coil while others vary for different coils. However, about fifty different elements would include all the elementary machine-handling operations occurring in the winding of several hundred different coils. If these elements were classified and filed according to product, they would be scattered through and mixed up with other elementary data relating to many different coils. The simplest and most effective proceeding is, therefore, to establish for this class of data a file having major divisions for kinds and sizes of machine and to provide subdivisions, of each such division, according to sections of machines to be manipulated. For this purpose the classification of machines and work-places used in the planning and control of work and in accounting serves as a base. The symbols are extended to designate the various sections of the machine. Such a classification also serves a useful purpose in the operation of a properly devised system for plant maintenance.

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[38] Pp. 875-876.

A great number of the small tools used in the performance of a specific operation may be used on other jobs quite different in character, and not only on the same but on different machines. In the work mentioned above as an illustration, a screw driver, scissors, small soldering-iron and a knife were used. One of our first steps in installing a system of scientific management should be to standardize, classify and symbolize small tools, and to arrange for their storage, provision and maintenance. The classification serving these needs lends itself admirably to the tabulation and filing of time-study data covering the use of small tools.

Materials, whether they be commercially purchased articles or semi-manufactured parts of a product, may also be classified with respect to those characteristics that affect the manner and time required to handle them. This, like many other tasks, is much less formidable when we get down to doing it than when we stand off and consider it. In this, as in the two preceding cases, the classification is useful in other ways. Needless to say, the same materials may in many cases enter into the making of several products and certain parts may have to be handled in several successive operations.

Morris L. Cooke's chapter on Classification and Symbolization in the Taylor Society book, "Scientific Management in American Industry," gives a good idea of the kind of classification to which I have referred.

Machine operating time is, as a rule, a simple matter of computation which can be facilitated by the use of tables, slide rules or calculating machines. The speeds at which machines may best be run when working on various materials inevitably involve research on the part of the methods man where no authoritative information exists. Even when it does exist, a little checking up is advisable.

To sum up, a logical plan should always be adopted for classifying, tabulating and filing data. In working out such a plan the methods man should have in mind: (1) accessibility and convenience in its use; (2) the fact that elementary operations occurring in one job may also occur on others; (3) applicability to new jobs or new products; (4) possible changes in equipment, products and materials.

With time studies made and tabulated in the manner I have attempted to describe, instruction cards defining methods and time have been successfully prepared in one non-repetitive shop for the past twenty years. In a large machine shop and foundry, operated solely for repair and maintenance, and building special new equipment for a very large works, instruction cards and tasks for every operation have been made up in this way since 1922. In the last mentioned instance, as a result of the installation of a complete system of scientific management, production was increased more than 100 per cent with an annual saving of half a million dollars.

VI. Selection of Standard Elementary or Unit Time

The methods advocated for selecting the standard time for a given element from a series of observations vary in detail, but most of them involve an averaging of the various times recorded. If all conditions were standard and if the worker being observed were first class there should be no variation, at least in theory, in the times for a given element, in which case, selection would be exceedingly simple and require no computation. It is equally true that in such a case an average would represent the correct standard unit time and require no computation for its determination.

Any considerable variation in a number of observed times for a given element (apart from unusual delays, which can be eliminated) indicates something wrong. With properly made studies the methods man will be able to identify the cause. The cause usually can and should be corrected before "standard unit times" are established. When this has been done it will be found that for each element the same time occurs in a majority, or at least a plurality, of the observations, and that consequently, the time that should be adopted as standard is evident at a glance, making computation unnecessary. This is a gauge of the quality of standardization, of the workers' ability and of the time-study work.

It should be borne in mind that, in using a stop watch, the recorded readings even of an experienced observer may be .005 to .01 of a minute above or below the actual time. Such errors are in many cases apparent from the finished time-study sheet and should be taken into account. Any averaging or calculation tends to establish inaccurate standards. To illustrate the foregoing, the following, based on a good example of time study of a cycle of elements, shows the results of selection by the calculation method described by Dwight V. Merrick, and the more direct method of selecting the predominant time in a series of observations. There were ten observations made.

ITEM	MERRICK'S METHOD (IN MIN.)	VISUAL METHOD (MODE) (IN MIN.)	PER CENT OF OCCURRENCES	MINIMUM TIME (In Min.)
A	.03	.03	70	.03
B	.0209	.02	70	.02
C	.0309	.03	70	.03
D	.0336	.03	50	.03
E	.0545	.06	40	.05
F	.0263	.03	90	.02
G	.05	.05	80	.04
H	.0565	.06	40	.05
I	.02	.02	100	.02
J	.0527	.05	50	.05
Total	.3754	.38		.34

Item F showed .03 occurring nine times and .02, the minimum, once. This single occurrence resulted in the calculated time being 12 per cent lower than if it had been discarded as abnormal. The lowering effect of a single .01 reading, together with nine .02 readings, would be more marked. In considering the visually selected time for items D, E, H and J, in relation to the percentage of total occurrences, light is thrown on the selection by the following. In the case of item D, .03 occurred five times, .04 twice, .05 twice and .06 once. In item E, .08 occurred twice, .07 twice, .06 four times and .05 twice. This item consisted of sprinkling a parting powder on the face of a pattern plate. The time which occurred twice as many times as any other reading, .06, was decided upon as ample for sprinkling a sufficient quantity of powder on the pattern. In passing, let me say that the methods man here observed three elements instead of one. They were: (1) pick up bag of powder; (2) sprinkle on pattern; (3) put bag back. It would have been physically impossible for him to record the stop-watch readings, however, as he would have then had eight consecutive readings averaging .028 minute each. Item H, an operation of the same nature as item C, contained .07 three times, .06 four times, .05 twice and .03 once. Item J contained .07 three times, .06 twice and .05 five times.

In the case of the study in question, we would have arrived at the same results, for all practical purposes, if we had discarded abnormal values, either high or low, and averaged the normal values as recommended by another authority. For the ten elements, this method would give us the following:

ITEM	MINUTES
A	.033
B	.023
C	.032
D	.033
E	.056
F	.029
G	.055
H	.061
I	.02
J	.052
Total	.394

As a further illustration of this point, I cite an example of time-study work by Mr. H. V. Williams at the Corona Typewriter plant. This was used by Richard H. Lansburgh as an illustration in his book, "Industrial Management."[30] Out of one hundred observations on two items, I find in the case of one item, that .09 occurred twenty times, .10 forty times and .11 thirty times. The average was .1022, and the minimum, .08, occurred but once. On the other item, .05 occurs twenty-three times, .06 forty-three times and .07 twenty-five times, with an average of .062. It is obvious that such time-study work requires no formula or calculation to ascertain the standard unit time. In passing I would remark that this is an example of excellent time-study work except for the fact that each of the six items shown includes several distinct elements.

There are various other methods, all involving averaging or other computation, which, as I have intimated, would be unnecessary if: (1) conditions and methods were standardized; (2) the work were performed by a "first-class" operator; (3) the time for true elements rather than for associated groups of several elements were observed and recorded; (4) detached cycles were studied independently rather than as they occur, as part of a complete job.

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[30] John Wiley & Sons, Inc., New York, 1923, p. 240.

The following is copied from another time study, showing the elementary times in a series of ten observations.

ITEM	OBSERVATION 1	2	3	4	5	6	7	8	9	10	STANDARD TIME (In Min.)
A	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
B	.02	.02	.02	.08	.02	.04	.03	.02	.02	.03	.03
C	.05	.05	.05	..	.06	.05	.05	.06	.05	.05	.05
D	.02	.02	.01	.01	.01	.01	.01	.01	.01	.01	.01
E	.04	.04	.04	.03	.04	.05	.06	.04	.05	.04	.04
F	.05	.05	.05	.06	.04	.06	.04	.06	.06	.05	.05

The process described by Messrs. Lowry, Maynard and Stegemerten, to which I have previously referred, I believe justifies the authors' statement that "the leveling method is the most scientific and accurate method yet devised" as a means of grading workers. It confines the factor of human judgment to a number of classified elements each of which is weighed independently rather than subjected to an over-all appraisal. As described, however, its purpose does not appear to be concerned in the main with the selection of the basic elementary time from a series of observations, but with the modification of such selected units to conform to the performance ability of an "average" worker. Under scientific management this plan would seem to have its greatest value in selection of workers and in the establishment of extra allowances over standard task time for inexperienced workers during training. These allowances should be regarded as temporary and individual if the management's aim is so to select, train and serve the workers that all will attain the production standard of the first class. They should, therefore, be added to standard task time for jobs to be done rather than be included in standard elementary unit times.

Percentages of Allowance in Addition to Standard Elementary Times

No feature of present methods-study technique is so open to unfavorable criticism as the fixing of the amount which, in setting tasks for specific jobs, must be added to the sums of the component elementary unit times. In a study of the existing literature relating to time study and the setting of tasks, one is struck by the contrast between the hazy manner in which this subject is treated and the comparatively clean-cut handling of others.

Apart from "unavoidable delays," which term covers a multitude of sins, these allowances should provide for, as may be required: (1) the worker's personal needs; (2) fatigue; (3) the lag or pause, often imperceptible, between the performance of one elementary operation and another; (4) variations in machine running time.

In my opinion it is erroneous, in most instances, to provide, as is sometimes advocated, for preparatory or incidental operations by including them in a percentage of allowance. They should be treated wherever possible exactly as are the elementary operations directly constituting the work to be done and the stages at which they occur, as well as their unit times, should be shown on instruction cards for the jobs in which they may occur.

These additions are all commonly embraced in the term "percentages of allowance." As an example, in Taylor's "A Piece-Rate System" we find as the last item of a rate for a machine operation, "Add — per cent for unavoidable delays."[40] Later, as a result of studies of heavy, laborious work, such as handling pig iron and shoveling, fatigue as a factor was recognized. This is indicated by Taylor's statement in "Shop Management": "The elements of the art which at first appear most difficult to investigate are the percentages which should be allowed, under different conditions, for rest and for accidental or unavoidable delays. These elements can, however, be studied with about the same accuracy as the others."[41]

The two terms "unavoidable delays" and "fatigue," as they were used in the past and to some extent even today, covered anything or everything for which it was considered proper to allow time in excess of the actual time required to perform the operation in question on the material being worked. As standardization became more complete and as the quality of management and its mechanisms improved, it was found that "unavoidable" delays became more and more rare. It may be stated as a rule that time for unavoidable or unusual delays should not be included as a part of the predetermined task time, which should be the time required to perform the task under standard conditions. The occurrence of such delays is irregular and the time that they consume is usually variable. While there may be exceptions to such a rule, I have found that in most cases "unusual delays" or "unusual work" may best be taken care of by the allowance of proper additional time upon the completion of the task. Generally, the accordance of such allowances would be based upon the investigation and report of the shop-methods supervisor. The necessity for taking extra cuts or for running at reduced speeds on account of the hardness of material is typical of causes for allowing extra time in machine-shop work. The breakage of yarn in weaving, mentioned in an earlier part of this paper, and the necessity for soldering ends of wire together in winding small magnet coils from enameled wire, because of breaks or burned sections, are other instances. The breaks that I have in mind here were due to unstandardized material, which, it was believed, might in the course of time be improved if not eliminated. The breaks varied greatly in frequency with different lots of material. Any allowance based on an average occurrence per job would be too high in certain cases and in others so low that the operator would lose his or her bonus. To meet the needs of such a situation we adopted the plan of providing a supplementary "job-time card" on which the operator made a mark as each break occurred. This slip was turned in at the completion of the job. The methods men then multiplied the number of breaks reported by the standard unit time for repairing a break and added the result to the standard time for the job.

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[40] P. 871.

[41] Pp. 167-168.

Whether or not a bonus should be paid on time for delays due to breakdowns or faulty equipment is an open question. Personally, I feel that it is a sound policy to pay bonus, that is to say, to allow proper extra time, for any delay for which the operator is in no way responsible.

Time for Operators' Personal Needs

This may best be determined on a basis of common sense, to suit the particular class of work and the surrounding working conditions. That this allowance should vary in what it provides for is well brought out by Mr. Neele E. Stearns in his paper "Computation of Allowances" published in the Bulletin of the Taylor Society of June, 1928:

> Though the items which come under this heading are limited in number, they are influential enough to warrant attention. In its baldest and most usual interpretation the term personal allowance covers only the worker's physical organ activities as influenced by his toil. In my mind, this percentage factor should vary according to the nature of the job at hand. For example, when a man leaves work at the end of the day dripping with perspiration as a result of his work in a rubber-mill room, it is good hygiene that he be permitted to bathe before leaving. The fact that thousands of workers still do otherwise does not lessen the hazard but only stresses the importance of our guarding our employes' health. Time spent in this way is not chargeable to fatigue, but has a direct bearing upon personal care. It should, therefore, not be a loss to the worker but should be allowed, together with his other average physical requirements, as a condition of his task and added to the calculated standard time in the form of a scientifically determined constant percentage. I cite the above as an example to point out the possible variations encountered in determining allowances. Most specialized tasks need only a body-care factor, and in that event the needs of the normal person should be determined and considered a constant percentage of the standard allowance time."[42]

The particular example cited, however, may not be the best, as time for washing up at the end of a day might better be allowed apart from time set for the operator's work. It, nevertheless, forcibly illustrates the point.

Lichtner in his book "Time Study and Job Analysis" points out another cause for variation in this class of allowances as follows:

> The amount of time to be allowed for the necessities of life varies considerably with the character of the operation, and in some cases even with the season of the year. In construction work, for example, which has to be done out in the sun without any shelter overhead, the workmen will require a great deal larger allowance in hot weather for taking many drinks of water, wiping off perspiration, and so on, than they will require in cooler weather. Thirty-three and one-third per cent was found to be the amount required on a construction job for these necessities of life whenever the men had to work out in the hot sun and the temperature was over 90 degrees.[43]

While I believe it would not be difficult to classify occupations and variable conditions, through the co-operation of methods men in various industries, and to establish uniform allowances for personal needs, my feeling is that accuracy in allowances for other purposes is in most cases of more importance and should first receive a treatment at least equal in quality to that accorded directly productive operations.

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[42] P. 150.

[43] P. 208.

Fatigue

Under the inadequate heading "fatigue" there has been rather generally included, apart from "necessary" or "unnecessary" delays, any variation between the actual time consumed in performing an operation and the sum of the unit times for its component elements, as indicated by observations over a period of one or more days. While, in some classes of work, such variation may in a large measure be due to fatigue, experience indicates that in many occupations fatigue is a negligible factor so far as it affects either the worker's performance or well-being. In the latter, fatigue is compensated for by the inherently diversified nature of suboperations or by periods of inactivity during which the worker is only required to keep an eye on machine operation and make an occasional adjustment. Typical of this is a large part of the work performed in general machine shops, in weaving, in knitting hosiery, in printing, etc. In some classes of work the method may be so devised that fatigue is offset by having the operator perform a useful incidental operation. An example of this was cited in my paper "Standards." Each girl folding handkerchiefs had to get up from her work-place after each twenty-five dozen, remove an empty tray and replace it with one filled with handkerchiefs to be folded; at another stage she was required to change a container filled with folded handkerchiefs for an empty one.

The theory that it is desirable to create conditions which will make it unnecessary for an operator to move from his or her working position for anything but personal needs is, in most instances, a mistaken one.

Muscular fatigue may occur in either heavy, laborious work, such as Taylor referred to in his description of handling pig iron, or in light, repetitive operations, such as he described in his example of inspecting bicycle balls. Taylor and Barth determined through their experiments at Bethlehem a law governing fatigue in heavy, laborious work. Taylor stated that a first-class laborer, suited to work such as handling pig iron, could be under load only 42 per cent of the day and must be free from load 58 per cent of the day. Practically, these men were made to take a rest, generally by sitting down, after loading ten or twenty pigs. This rest was in addition to the time that it took them to walk back from the car to the pile. If rests occurred after handling every twenty pigs, they would have come at the end of every 8.64 minutes during the day and have been of 1.77 minutes duration. Taylor further stated:

> As the weight grows lighter the man can remain under load during a larger and larger percentage of the day, until finally a load is reached which he can carry in his hands all day long without being tired out. When that point has been arrived at this law ceases to be useful as a guide to a laborer's endurance, and some other law must be found which indicates the man's capacity for work.[44]

With regard to fatigue in the case of the bicycle-ball job, a careful examination was made of the way in which each girl spent her time. An accurate time study was undertaken, through the use of the stop watch and record blanks, to determine how fast each kind of inspection should be done, and to establish the exact conditions under which each girl could do her quickest and best work without danger from overfatigue or exhaustion. Even when the hours of labor had been shortened from ten and a half to eight and a half *a close observation of the girls showed* that after about an hour and one-half of consecutive work they began to get nervous. *It is wise to stop short of the point at which overstrain begins* and therefore ten-minute periods for recreation were arranged at the end of each hour and one-quarter. During these recess periods the girls were obliged to stop work, leave their seats and get a complete change of occupation by walking around and talking, etc.[45]

Here we have two concrete examples of determination of fatigue and provision to offset it, both of which are based on studies made over thirty years ago. It is interesting to note that H. L. Gantt was General Superintendent of the factory in which the "bicycle ball" experience took place and that S. E. Thompson made the studies in the course of reorganization work under Taylor's direction. One of the examples covers work calling for nothing but heavy muscular effort, while the other relates to the lightest kind of work in which concentrated attention of eye and mind, together with dexterity and speed are necessary. In the first instance, the allowance for fatigue or rest periods was 20 per cent of the active time, at intervals of 8.64 minutes, and in the second, the allowance for fatigue, strain or nervousness amounted to 13.3 per cent of the actual working time while the rest periods were only necessary every hour and a quarter.

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[44] *The Principles of Scientific Management, op. cit.*, p. 58.

[45] *Shop Management, op. cit.*, pp. 85-91. Also, *The Principles of Scientific Management, op. cit.* pp. 91-92.

From my own experience, I would cite a case in which girls performed light, repetitive work which called for speed, dexterity and keenness of vision. The operation consisted of twelve simple, elementary motions consuming one-tenth of a minute in all. It was here found that fatigue began to be apparent at the end of fifty-five minutes and that three minutes of rest offset it. Another instance involved making small molds on a machine in a foundry and required skill and speed, together with the handling of the finished mold weighing about thirty pounds. This operation consisted of forty-one elements and took 1.85 minutes to perform. It was found that fatigue became evident at the end of forty minutes and that five minutes of rest offset it. Time study in the two latter instances indicated fatigue unmistakably. For instance, it was found in the molding operation that, when the worker started a run of molds, the time for the first mold was about 15 per cent longer than the standard; each succeeding one was a little less until after about five molds he got into his stride and turned out mold after mold in the standard time until fatigue manifested itself. Then the time per mold fluctuated in a most erratic fashion. The fluctuation was obviously due to fumbling.

It would appear that fatigue, where it is a factor to be dealt with, does not gradually build up as the day progresses with a proportional slowing down in speed. My experience has indicated that operators engaged in the performance of properly set tasks under standardized conditions will work at the same rate during any period of the day.

The type of rest period referred to above is of undoubted importance in regard to both the attainment of high production and the worker's well-being. To date time study of each class of work done in each establishment seems to be the most practicable means of determining whether or not rest periods are needed and how frequently they should occur.

The value and necessity for general rest periods, or recesses, of ten or fifteen minutes in the middle of the forenoon and afternoon is, I believe, in many instances open to question. Too often they are inaugurated because someone thinks it would be the kindly and nice thing to do without any facts upon which to base such a conclusion or to prove its justification. If the work is of such a character as to require rest periods of the type discussed and if time is allowed for them, and for personal needs, it may be asked "What need can there be for these mid-morning and mid-afternoon recesses?" It would seem logical to assume that they are not necessary where an operator works on several different jobs during the day, especially where each job is of such a varied nature that neither fatigue nor monotony is a factor and where the worker leaves his machine to change his job time card after completing each job and to take care of bodily needs. On the other hand, it would seem that, if work is monotonous even though not fatiguing, or if it calls for a degree of concentration, or is performed in surroundings that induce nervousness, recesses might be necessary. Perhaps the best argument that can be advanced for them is that they may contribute to keeping the workers contented through the opportunity that they offer for recreation or social intercourse. In Japan I found the practice of having morning and afternoon rest periods almost general, and in a number of plants everyone, from the officials down, devoted a part of such periods to calisthenics in groups, under a leader.

As Mr. Stearns says in his paper to which I have previously referred: "Untold quantities of material have been prepared by innumerable authorities on the loss of productive power in the worker because of fatigue, the value of rest periods to offset this evil, and the effect of incorrect lighting, unsanitary working conditions, etc., in slowing down production." And yet, so far as I know, the laws governing fatigue have not been ascertained except as they may apply to individual cases, nor have results of investigation been so formulated as to be of help to the engineer and manager in dealing with specific, practical production problems.

Laboratory research in regard to fatigue, so far as I am acquainted with it, has not been of such a nature as to make results directly usable in the determination of allowances for fatigue. In this, as in the selection of workers, there is need for effective co-operation of the engineer and manager with specialists in other fields, to the end that results may be both more scientific and more practical. This is, however, management's problem primarily and the initiative in its solution must be taken, I believe, by those most directly concerned with it.

Allowance for Lag Between Elementary Operations or Cycles

As far as possible, it is desirable that the standard unit or elementary time should be "net." For example, omitting any allowance for physical fatigue, personal needs or unforeseen delays, the total time that a "first-class" operator will consume in performing an operation consisting of, say, fifty different elementary operations will be longer than the sum of the standard unit times for these elements determined by the method that I have described. This may be attributed to the lapse of time between thinking and putting the thought into action. To cover this a percentage must be added to the sum of the elementary or unit times. These component elementary operations may be used in various combinations involving many or few of them. Taylor pointed out that this percentage is quite large on jobs made up of a large number of different elements comprising a long sequence infrequently repeated. This factor grows smaller, however, as the work consists of a smaller number of different elements in a sequence that is more frequently repeated.

Such allowance is often listed on instruction cards as "allowance on handling time." The method followed for its determination in the case of simple repetitive work such as the folding of handkerchiefs mentioned in my paper on "Standards," is reasonably satisfactory and accurate as it applies to the specific cases concerned. I refer to comparison of the time for an operation built up from elementary unit times, with the time actually taken per piece, as shown by a protracted "over-all study" from which the time taken by things which do not directly apply to the performance of the operation has been eliminated. If the laws governing this class of allowance were formulated much time and expense due to duplication of effort by different companies might be saved.

In plants where the work is complicated and either non-repetitive or repeated only at long intervals, and where the percentage of allowance on portions of so-called "handling time" or for certain jobs, is as high as 100 per cent, the existing practice and formulae are far from satisfactory even though, under a high-class methods man of long experience, results may be satisfactory to both employer and employe. This has been a source of just criticism. It was as a result of studies started at the Tabor Manufacturing Company with a view to developing a more accurate method of determining such allowances that Taylor's theory, which I have quoted, was evolved. However, these studies were interrupted by the World War before they were carried to a point which would have permitted the development of formulae. It is hoped that this paper may arouse interest which will result in similar studies being undertaken by others. In conducting such research studies for each class of work, there should be selected a number of jobs ranging from the simplest and shortest to the most complicated. These should be studied to determine the necessary percentage of allowance where work is done singly or with a varying number of repetitions.

For reasons which I have indicated, the practice of adding "percentages" to the elementary time in establishing standard unit times would seem to be inadvisable and to indicate that additional allowances should be computed for each job according to its degree of complication and frequency of repetition.

Conclusion

The late Frank B. Gilbreth had a vision of methods studies, or as he expressed it "time and motion studies," being undertaken by and for not a single company alone but all companies in a given industry. Although he perhaps thought of it at the time primarily in its relation to piece work, Taylor had this in mind when in 1895 he said in his "A Piece-Rate System," "There are hundreds of operations which are common to most establishments, yet each concern studies the speed problem for itself, and days of labor are wasted in what should be settled once for all, and recorded in a form which is available to all manufacturers."[46]

I recall also in an early discussion with Gilbreth on the use of the moving-picture camera as a means of making and recording studies that we talked of the possibility of ultimately analyzing, classifying and making time studies of all the elementary bodily movements that might be employed in various combinations in performing any operation.

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[46] P. 875.

While a full realization[47] may not be expected in the near future and may not be accomplished in the time, or with the facilities, at the command of those concerned with the practical application of methods study to the production problems of today, progress has been made and it is hoped that work in this direction will be continued and arouse the interest which it deserves. Such work might well be carried on by some of our institutions of learning just as psychological or physical research has been carried on in the past.

It is, however, of far greater immediate importance that methods study conducted along demonstratedly practical lines should be undertaken by and for the benefit of specific branches of industry as a whole. Associations of manufacturers have from time to time in the past undertaken the development of uniform systems of accounting and the investigation of problems relating to design and to materials used in their common products. It seems almost beyond belief that they have not also availed themselves of the great opportunities that joint methods studies would afford. I suggested such a course in a paper read before the American Foundrymen's Association in 1915.

I have the impression that, so far, the only group co-operative effort that has been made in this direction has been in some two or three instances of time studies undertaken jointly by trade unions and employers with the limited object of setting more accurate and equitable piece rates than had been possible by negotiating. Sooner or later, however, as management becomes more enlightened, I feel that the merits of the course here suggested will be appreciated and that such group methods study may lead to a great advance in many of our industrial arts. This would seem to be one of the objectives of the European movement known as "rationalization." I quote Oliver Sheldon's definition of the term:

> Rationalisation is the process of associating together individual undertakings or groups of firms in a close form of amalgamation, and, ultimately, of unifying, in some practicable degree of combination, whole industries, both nationally and internationally; with the allied objects (beyond what is possible to an industry divided into many competitive units) of increasing efficiency, lowering costs, improving conditions of labour, promoting industrial co-operation and reducing the wastes of competition, these objects being achieved by various means which unification alone makes in full measure available —the regulation of the production of an industry to balance the consumption of its products; the control of prices; the logical allocation of work to individual factories; the stabilisation of employment and regularisation of wages; the standardisation of materials, methods and products; the simplification of the ranges of goods produced; the economical organisation of distribution; the adoption of scientific methods and knowledge in the management and technique of trades as a whole; and the planning and pursuit of common-trade policies.
>
> Or, to use the terms already employed in this discussion, rationalisation is that form of industrial combination which is undertaken with the object of widening the scope for the application of scientific management to the extent of whole industries, and achieving the benefits to producers, consumers and the community which scientific management conducted on this scale alone can provide. In a word, rationalisation is not combination, nor is it scientific management; it is, rather, a form of the one with the object of the fullest extension of the other.[48]

A survey such as I have made of the practice of methods study or, as it is most frequently designated in the literature on the subject, "time study" and "job analysis," shows that while the trend is in the right direction there still exist great differences in technique and in conceptions of underlying principles. Likewise, though much of prevailing practice for the time being meets present needs, it falls far short of being truly scientific or even good. That there is a need for better understanding and agreement as to the purposes, principles and practices both in the conduct of methods studies and in the utilization of their results, was strikingly brought out in the discussion of the paper presented by S. E. Thompson at the December, 1927, meeting of the Taylor Society and in the sessions of the 1928 spring meeting devoted exclusively to time study.

Frank B. Gilbreth said in an article published sixteen years ago in the *Journal of Political Economy:*[49] "The great need now is for more efficient co-operation, that work done by one investigator may not be needlessly repeated by another. Through such co-operation only can come the savings that will allow of refinements of the units, methods and devices of measurement that will result in progress that is definite, constant and lasting. If the members of the Taylor Society agree as to the existence of these needs, the questions to be answered are: What can we do about it? How? When?

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[47] Gilbreth, Frank B. and Lillian M., "Classifying the Elements of Work" and "Applications of Motion Study," *Management and Administration*, Vol. VIII, Nos. 2 and 3, August and September, 1924, p. 151 and p. 295. In these articles the Gilbreths discuss "therbligs," the term covering the elements essential to all physical work. In their opinion there are seventeen of these essential elements or "therbligs."

[48] *Scientific Management in American Industry, op. cit.*, p. 15.

[49] Gilbreth, Frank B., "Units, Methods and Devices of Measurement under Scientific Management." *Journal of Political Economy,* Vol. XXI, No. 7, July, 1913, p. 629.

That there is need for more research of a fundamental character is obvious. Such research would be of inestimable and far-reaching value but I doubt if any but a very large company could afford it alone, and of those who might, it is doubtful if any would have the vision or inclination to defray the cost. It might be regarded as a proper undertaking for one of the numerous foundations but my impression is that their interests lie in other directions. Nevertheless, when we think of the vast amount of research work that Taylor managed to accomplish during his professional career and compare the present state of the art of methods study with its state when Taylor withdrew from active practice, it does not reflect much credit upon those of us who are today engaged in the application of his teachings. Are not Taylor's accomplishments a challenge as well as an inspiration to the engineer and manager of today?

Discussion

G. J. Stegemerten.[50] Mr. Hathaway's close observation of innumerable industrial activities as a consulting engineer has placed him in a most advantageous position to speak authoritatively on this and kindred phases of scientific management.

My discussion of the subject will be from the point of view of one connected with a single manufacturing concern and hence might be termed "special" in its scope.

In making detailed analytical studies of the procedure followed in performing an operation, two recognized systems are in use. The equipment used and the manner of making the studies are different but the fundamental principles involved are the same and date back to Frederick W. Taylor. One of these systems is called, by its exponents, "motion study" while they (the exponents of motion study) refer to the other system as "time study." The followers of the second method, however, call their practice "time and motion study."

The terms "time study" and "motion study" used alone are misleading, for each, used alone, implies the exclusion of the other. In reality a time study would be of little value if it were not based upon a careful and analytical motion study. Nor would a motion study, failing to take the element of time into account, amount to more. The complete title of either method should really be "motion and time study."

Motion study, as distinguished from time study, involves the intensive study of the motions used to perform an operation and is made under laboratory conditions by means of highly accurate and comparatively expensive equipment. The operator and the necessary equipment are moved to the laboratory, or special screens and recording apparatus are set up in the shop. A motion picture is taken of the operator while working. A special time-recording device is placed in the field of the camera so that the time required to perform the elementary operations may be taken directly from the film, thereby introducing the element of time. Individual motions are studied by attaching small electric lights to various parts of the operator and by making a photographic record of the path of those lights.

When and while the data are being collected, improvements are made which reduce the number of motions required to a bare minimum. When the supposedly best method has been determined, every operator involved is taught its use. (This is in line with that part of Mr. Hathaway's paper which emphasizes the importance of improving methods, instructing workmen, etc.) In this way the element of individual skill is almost eliminated by teaching each operator to be highly skilled. It is expected that effort will be stimulated by establishing a time allowance for doing the job and then offering the worker an incentive to beat it.

Time study, also, subjects each operation of a given piece of work to close analysis but accomplishes this by means of personal observation. This is also done in order to eliminate every unnecessary operation and to ascertain the quickest and best method of performing each necessary operation; also to standardize equipment, methods and working conditions. When the preliminary analysis has been completed, the number of standard hours in which the average experienced man can do the job is determined by time measurement. It will thus be seen that the purpose in mind here differs little from that of motion study.

What we consider as "average," Mr. Hathaway and others, supported by Mr. Taylor, term "first class." The fact of the matter is that when we think of "average" we really mean "average good" and have instructed our men to bear this in mind in grading effort, skill and conditions. It is not hard to conceive of a group of, say, lathe hands none of whom might be considered "average" as we see it. In other words, we compare performance with what we believe to be reasonably good for that activity throughout the works.

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Under time-study methods, the equipment used is a stop watch and the necessary printed form. A study of motions is made by analytical observation on the part of the time-study man. He devises new and improved methods and experiments to find the quickest way of doing the work. The time study is taken only when the method has been standardized.

Motion-study methods have been used, and apparently very good results have been obtained, in many lines of industry. It would seem to be most applicable to work of a standard nature requiring the repetition of a series of dextrous motions.

The only place where time study might not be used to advantage would be on very short jobs. There old-fashioned estimating would probably give good results, but even these estimates should be based on a background of knowledge obtained from analytical time study. Where lots are small not so much time need be given to making the study, for in this case the object is to establish a time value quickly so that the operator will do that particular order as quickly as possible. Where the product is more standard and repetitive, a correspondingly longer time should be given to analytical observations.

Our opinion of the qualifications of one setting out to do time-study work is essentially the same as Mr. Hathaway's, who has stated clearly how and where men of different attainments fit into this work.

To make an intelligent methods study, the analyst must have experience. He must have the confidence which comes from a thorough knowledge of the things under consideration. He will be naturally intelligent and will have not less than the equivalent of a high-school education. He will be thoroughly analytical and will have sufficient salesmanship to convince the workmen and others that his suggestions and recommendations possess merit. He will have an agreeable and positive personality and will command the respect of those with whom he works.

Among the things which must be considered in making a study of methods, the following will have been given serious thought: equipment, such as machines, tools, jigs, fixtures and the adaptability of such equipment to the work at hand; working conditions (light, heat, ventilation and the nature of the work); the supply of raw materials and the removal of finished parts, and the method of receiving information and instructions.

Having given these points careful consideration, the analyst will proceed further with his detailed study, which should involve satisfying himself on the following questions in the case of each element observed: Why is this element being performed? Is it necessary? Is it being performed in the best possible way? Can it be combined with another element? Is it being performed according to proper sequence?

By subjecting the finest subdivisions of an operation to the close scrutiny just described, the operation, or sets of operations, which constitute an activity, will be found to contain essentials only and hence will result in greater production, at less cost to the company and higher wages to the workman.

A few examples will tend to illustrate what has been accomplished in our plant by an intensive analysis and study of methods, followed by time study, and the application of the standard-time, wage-incentive plan. The specific cases which I shall give exemplify to a marked degree that which may be accomplished by methods study, especially as concerns the improvement of methods.

In the forming, baking and sawing of micarta tubing eight operations, of a total of nineteen originally performed on day work, were improved and three which were found unnecessary were eliminated.

On a day-work basis, mandrels were not kept in an orderly manner and were not identified; only one job was worked at a time. The operator waited while the pouring press heated and cooled; material was not located near the work station, and some operations, which might easily have been performed by girls, were performed by men.

As a result of methods study, the following improvements were made prior to placing the work on an incentive basis. The mandrels, which were stored at a distant point, were subdivided according to sizes, identified by proper markings and stored in convenient racks. A rack was also located alongside the press to accommodate the most active mandrels. Instead of working on a single job, several jobs were worked upon simultaneously, hence eliminating a large amount of waiting time. The operators on standard time performed other work while the presses were heating and cooling. The material was placed close to the machine. Girls were substituted for men on certain operations.

On a day-work basis, twelve men were required to get out the load, while on the incentive basis, after these improvements were made, six operators were able to handle it without difficulty.

Another example is the case of "line starter relays" which were formerly assembled on an ordinary work bench. Due to irregularity in the flow of material, certain parts were not matched or on hand when needed. This resulted in apparatus being in various stages of completion. At times when a part was received it was assembled to another part and then stored on top of, or under, the bench until more material was available.

In observing this job as the activity increased, it was evident that the method used could be considerably improved. It was decided that the job would lend itself to progressive assembly on a belt conveyor. This meant, of course, that the various elementary operations would have to be balanced. In other words, a smooth flow of the work was arranged involving the securing of additional equipment for the elements requiring the greater amount of time. Hand-automatic screw drivers were replaced by power-driven ones. Material racks were located in the most advantageous positions. The spraying of paint was formerly done in one central place for the whole department. One of the spray booths was moved to the end of the belt conveyor and after the parts were sprayed they were placed on specially constructed trays and racks to dry. After drying they were set on the belt conveyor and removed by the assembler. A larger turn-table than was previously in use was made. This permitted the spraying of a loaded rack at one time. A new method of testing for open circuits was arranged. The end of the bench was cut out to admit a tote skid which received the finished apparatus at the end of the conveyor belt.

The packing of all apparatus in the department was formerly done at one central point. This operation is now being done on the belt conveyor, which eliminates transportation. Numerous other small changes, including a more efficient method in the final testing, were made, which in the aggregate netted a considerable reduction in time.

Having established the proper method, time studies were made and a time based on the new method was established. The changes made cost about $1000.00, while the yearly labor savings amount to $10,000.00.

The results of a study on the assembly of another piece of apparatus, composed of a circuit breaker, a motor-operated mechanism, a network master relay and a network phasing relay, amounted to a time reduction of from 64.50 to 35.17 hours.

The assembly of paper-mill and arc-welding sets was performed as day work prior to April 1, 1929, when it was placed on an incentive basis. When studying the group for standard time, the location of floor plates and material was found to be inefficient. The operators had to hunt for material due to a lack of system and planning. The material was not placed near assembly so that the operator could keep a check on it. Handling facilities were not provided and this meant that the operators had to make use of a large traveling crane. Much lost time of the operator was due to waiting on lifts, since the traveling cranes were not always available. Furnaces and special small equipment for hand operations were not available. The operators had to cart some of the armatures and rotors to various parts of the section, which meant lost time. It was decided to relocate the assembly floor plates and material. The floor plates were placed in a location near the windows, about eighteen inches above the floor, to make working conditions as good as possible, and the material was placed close at hand in proper storage racks. The proper handling facilities were provided, i.e., jib cranes, mono rails, furnace and small shears. The operation was then time studied with the result that the time required to perform the necessary work was reduced from twenty-five to thirty hours per piece on day work to ten and twelve hours per piece on standard time.

An intensive study of the various operations performed on commutator bars again brought about favorable results. The layout of equipment was changed from a haphazard arrangement, in which a great deal of hand trucking between machines was required, to a roller conveyor layout which was arranged in the shape of a horseshoe. The new set-up so facilitated production that a time reduction of nearly 50 per cent was made.

These examples are typical of a number of cases reported monthly and illustrate what may be accomplished by a close study of methods on the part of a well-qualified analyst.

That part of Mr. Hathaway's paper which dealt with the classifying and tabulating of elementary time units, from which time allowances for similar jobs might be synthetically ascertained, is to me extremely important.

It is true that scarcely two operators will give the same reaction under observation, nor will the same operator always duplicate his performance on different occasions.

Recognizing the inconsistency of human nature, I am convinced that the construction of standard data, or formulae, as we call them, is sound. Such formulae must, however, be based upon representative time studies taken on different operators engaged in the same activity.

Once the operator is convinced of the accuracy and fairness of a formula over the entire range of work, his suspicions (if he had any) are overcome and he proceeds with that peace of mind which is prerequisite to maximum production with a minimum of effort.

Aside from the many advantages to the workmen, formulae enable the analyst to set many more allowances than he could establish by time study, and, what is more, the values are more consistent and may be set before the job goes into work.

At the East Pittsburgh Works of the Westinghouse Electric and Manufacturing Company in the neighborhood of 100,000 time allowances are set monthly, and of this number, 80 per cent are established by formula.

I might say, in conclusion, that we have accomplished in our works that which is recommended in the latter part of Mr. Hathaway's paper; namely, proper dissemination and exchange of information. We have prevented the duplication of effort by "broadcasting," so to speak, all information which is found to be acceptable and apparently of general application. What is more, we have instructed all time-study supervisors to consult the Central Office before starting to collect data on an activity, in order that they may be given the benefit of the experience of others.

Unemployment[1]

An Individual Problem Which Has Become a Social Problem

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UNEMPLOYMENT has long since ceased to be the problem of the unemployed person alone. The inevitable social disruption which it brings has become so familiar that unemployment is now definitely recognized as a community problem. In recent years it is also recognized that the regularization of operation is a legitimate obligation upon industrial management which is increasingly aware of its stake in the maintenance of the purchasing power of wage-earners.

The difficulties in dealing with unemployment are complicated by the vagueness of existing knowledge concerning it. The number of unemployed cannot be estimated with a satisfying degree of confidence in terms of existing data. Estimates vary widely with the method of measurement used and with the definition of unemployment. An attempt to measure unemployment is faced by two alternatives: (1) indirect measurement—estimating the margin between the total supply of labor and actual employment; (2) direct measurement—counting the unemployed by means of a special census or by direct registration. In the United States, where there is no adequate continued registration of the unemployed, measures of unemployment have been derived in one way or another from statistics of employment. Although statisticians tend to confine their efforts to measuring changes in the volume of employment, this is by no means a substitute for unemployment measurement. A sharp falling off of employment in one industry may be offset by an increase of employment in another, the result being that there is no net decrease of employment when both industries are considered together. Reasonably exact measurement of unemployment is needed to gauge the effectiveness of such means of control as may be devised, and to guide protective and relief programs.

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[1] From advance proof of *The Social Work Year Book for 1929* about to be published by the Russell Sage Foundation, 130 E. 22nd Street, New York. This article is typical of the wide field of information covered by this book. It should be of interest to those engaged in all phases of management.

History and Present Status. Every period of unemployment has brought its lessons—if not teaching what to do, at least demonstrating what to avoid doing. During the depression of 1894 community activity was centered in large central relief committees operating with a central fund. "Made work," frequently of an unsuitable sort, was supplied to applicants. In the next depression emergency committees were discouraged and existing welfare agencies expanded their own programs of relief and emergency employment. The brief period of unemployment in 1914 witnessed increased activity on the part of social agencies, settlements, and educational clubs, but there was often duplication of effort by neighborhood agency and central authority.

The last two unemployment crises have witnessed not only community but state and federal activity. In 1921 President Harding called an unemployment conference to consider emergency measures and measures of prevention. This conference urged mayors of American cities to take prompt leadership in organizing emergency committees on unemployment. The mayors' committees were generally less satisfactory than spontaneous committees from among groups whose natural interests brought them in continuous contact with the problems. The functions of these committees were to study the situation and form general plans, to give publicity to existing needs, to administer and coordinate employment services and relief, and to encourage employment of the jobless by individuals, firms, agencies, and municipal departments.

Such in general are the relief measures adopted by volunteer committees in dealing with emergencies in the absence of programs of prevention or control. Naturally the organizations most conspicuously identified with these measures have been the public and private family welfare agencies of the country. A gradual crystallization of opinion has been influenced in large degree by the writings of the late Mary E. Richmond. The dangers of large central funds for unemployment relief or emergency work are shown graphically by her much quoted illustration of a crowded theater when a cry of fire is raised. If all exits are locked except the main one panic results. Likewise, publicity concerning large central sources of assistance in an unemployment crisis tends to detract attention from such normal means of escape as migration, change of occupation, part-time work, savings, credit, friendly assistance from individuals or from relief agencies, and emergency opportunities for work. Publicity given to local relief funds also tends to attract large numbers of the unemployed from elsewhere. In place of such methods there should be organized cooperative registration of applications for aid and opportunities for relief work without publicity. (*See* "The Long View" and "The Time to Plan is Now" in the references appended to this article.)

The causes of unemployment are inseparably bound up with the problems of industrial instability. Employment fluctuations must be attributed to seasonal movements in market demand, to cyclical changes in business activity, and to those irregularities in industrial progress which permanently modify the structure, technology, and geography of industry. Since the causes of unemployment are manifold and interactive, it is impossible to designate certain preventive or remedial measures as specific in dealing with particular types of unemployment. The problem must be viewed in its entirety, and must be attacked in various ways and from different angles.

Experts have long agreed that much of the slack in employment may be taken up by means of a coordinated national system of employment exchanges which will make it easier for every job to find a worker. At present separate reserves of labor are maintained by industries and localities that could draw upon a common reserve. *See* "Employment Agencies." The control of seasonal employment is primarily a problem of market analysis—spreading work over the year instead of operating on a hand-to-mouth production schedule. Individual plants and industries have dealt successfully with these problems, but further experiment and research are needed to demonstrate whether regularization on a plant or on an industrial basis gets at the roots of unemployment at large. Cyclical unemployment presents delicate problems of economic balance and of monetary and credit control to which more scientific attention is now being given than ever before.

Even if the labor market were perfectly organized, with seasonal fluctuations eliminated and the business cycle substantially under control, certain causes of unemployment would continue to operate in the form of dislocations due to the changing consumption habits of the people, to the decline of old industries and the growth of new ones, and to improvements in industrial efficiency which temporarily or permanently reduce the amount of labor required in particular industries. Strictly speaking, there is no such thing as "technological unemployment" existing apart from unemployment in general. The impact of technical changes upon employment may be felt in the form of (1) a shift in the type of worker required in a given industry, or in the form of (2) a temporary or permanent reduction in the number of workers required in a given industry. Thus it is entirely possible that technological changes in individual industries or plants may affect the identity of the unemployed without affecting their numbers. More important, however, is the influence of changing productivity as one of the leading factors in determining the amount of employment and unemployment. Technological progress has been accelerated at various times in the past as at present; whether there is anything new about the present technological situation depends upon the extent to which American industry can take care of increased productivity by expanding its foreign markets to compensate for decreased elasticity in its domestic markets.

To mitigate the social effects of "residual" unemployment it is argued that a system of national employment exchanges and effective regularization of industrial operation must be supplemented by planned protection of the individual worker from that unemployment which neither the individual nor society can prevent. Protection against unavoidable unemployment means insurance or relief in some form. It is urged that industry should set aside reserves against slack times, either maintaining employment or spreading out compensation to its workers in terms of an annual wage, or that the worker and the state should share the cost of protection as in some European countries. Notable among voluntary industrial insurance plans is the scheme now in operation in the men's clothing industry in Chicago. State unemployment insurance has as yet won few supporters in the United States. (*See* "Personnel Administration in Industry.")

During the current depression urgent stress has been laid upon the importance of public construction. Forward planning of public works depends upon adequate forecasting and the quick availability of a public reserve for construction.

Development and Events, 1929. The spring, summer, and early fall of the year marked continued steady recovery from the semi-depression which had set in during the preceding winter of 1927-1928. In November, however, employment fell off sharply, signaling the beginnings of the most severe depression that has been felt since 1921. Again an emergency found the country without adequate information regarding the volume of unemployment. Widely divergent guesses regarding the extent of earlier unemployment had been made during 1928. These were critically summarized and new unemployment estimates up to 1928 were developed in the comprehensive report made by the National Bureau of Economic Research in May, 1929, to the President's Committee on Recent Economic Changes.

Persistent agitation for more adequate information regarding unemployment culminated in Congressional provision for an unemployment inquiry in the 1930 census of population. The census of 1930 will undertake to distinguish only those unemployed at the time of the census, with a minimum of information regarding the causes and extent of unemployment. The plan allows for a separate tabulation for every person who usually works at a gainful occupation but was not at work on the day before the enumerator's visit—or on the last regular working day. There is sharp disagreement regarding the adequacy of the final schedule and procedure developed for this census, since many modifications of the preliminary recommendations of experts were made by the Census Bureau on grounds of expediency. Early releases of partial returns from the census are subjected to sharp criticism as this volume goes to press.

Local censuses of unemployment were taken during the year in Baltimore, Philadelphia, Cincinnati, Buffalo, and Urbana-Champaign, Ill. Other cities are inaugurating similar surveys, a number of them to be repeated at periodic intervals. These local investigations furnish evidence of increasing popular desire for reliable current facts regarding unemployment. They will furnish interesting supplementary checks against the national census of unemployment.

Toward the close of the year there was widespread organized community effort to study unemployment and to anticipate its recurrence by the development of means of prevention and control. Local committees were usually more representative than in previous depressions, including in their membership industrial and labor leaders, public officials, social workers, experts, and scientific investigators. A permanent committee on the stabilization of employment was appointed by the City Manager in Cincinnati prior to the depression. Working through numerous subcommittees, it successfully dealt with emergency unemployment during the winter while at work at the more difficult task of devising means of prevention and regularization. In Philadelphia a chamber of commerce subcommittee on unemployment, also organized before the depression, cooperated closely with the Federal Reserve Bank, the Department of Industrial Research of the Wharton School, the Board of Education, and other civic bodies in the development of a far-reaching program for regularization of employment and the decrease of unemployment. The Cincinnati and Philadelphia plans are furnishing the pattern for local organization in many localities.

In New York State an Advisory Committee on Employment Problems completed an intensive analysis of the operations of typical employment offices and has submitted recommendations regarding the improvement of the state employment service. Shortly after the close of the year—in January, 1930—Governor Roosevelt appointed a state Committee on the Stabilization of Employment to "assist the employers of the state in a gradual progress toward stabilization based on authentic American business experience and rising out of and adapted to their own local industrial problems." Organized state activity is also forecast in Ohio and in Wisconsin. The coming two years will show whether these local plans will end in paper schemes or whether they hold the promise of more permanent and effective attack upon unemployment.

Recognizing the emergency, President Hoover in December utilized the machinery of the Chamber of Commerce of the United States to create a National Business Survey Conference to recommend and organize courses of action looking toward the maintenance of normal business activity. Through this Conference the administration called upon industrial leaders to maintain employment and production at a high level, at the same time developing a nation-wide program for the acceleration of public works. During the year the United States Bureau of Labor Statistics expanded its employment and payroll statistics to include samples from such important non-manufacturing employment groups as mining, public utilities, wholesale and retail trade, hotels, canning, and preserving. It is too early to judge the adequacy of the rather small samples included in the Bureau's figures.

The President's Committee on Recent Economic Changes is undertaking the development of a continuing series of studies stressing analysis of the techniques of economic balance. A study of employment and public works and several other related investigations are being carried to completion for the Committee by the National Bureau of Economic Research. An interesting development of the year was the expansion of the Russell Sage Foundation's comprehensive monthly reports showing fluctuations in the amount of relief and the number of cases handled by a large number of relief agencies, public and private. *See* "Statistics and Social Work." In April a conference on the regularization of employment was held at the University of Pennsylvania in which a number of experts participated; a continuing program of conference and discussion of technical phases of unemployment research is to be developed by the Social Science Research Council, and a permanent unemployment study is to be organized at Swarthmore College.

Three important bills relating to unemployment were pending in Congress at the end of the year. They were introduced in the Senate by Robert F. Wagner of New York, proposing a national system of employment exchanges, a plan for improved unemployment statistics, and a national reserve for the subsidy of public works. These bills are being opposed by the National Association of Manufacturers. Without administration support or sanction their fate is uncertain.

It is apparent that recurring depressions have found the industrial community increasingly aware of the real nature of the unemployment problem and of the inadequacy of emergency measures. The President's Unemployment Conference of 1921, the activities of its subcommittees, and the constructive program of the Department of Commerce have contributed much to the change in point of view which characterizes the attitude shown toward the present depression. Wartime industrial organization has left as a legacy a better understanding of the possibilities of coordinated effort. While the present widespread concern about unemployment persists, the time is ripe for the more effective control of employment and an understanding of the problems involved.

CONSULT: Beveridge, Sir William H.: *Unemployment a Problem of Industry,* 1909; Klein, Philip: *The Burden of Unemployment,* 1923; Lescohier, Don D.: *The Labor Market,* 1919; Lewisohn, Draper, Commons, and Lescohier: *Can Business Prevent Unemployment?* 1925; Feldman, Herman: *The Regularization of Employment,* 1925: Family Welfare Association of America: *The Time to Plan is Now,* 1929; Richmond, Mary E.: "Emergency Relief in Times of Unemployment," in *The Long View,* to be published in 1930; Harrison and Associates: *Public Employment Offices,* 1924; Hurlin and Berridge: *Employment Statistics for the United States,* 1926; Lubin, Isador: *The Absorption of the Unemployed by American Industry,* 1929; Myers, Robert J.: "Occupational Readjustment of Displaced Skilled Workmen," in *Journal of Political Economy,* August, 1929; National Bureau of Economic Research: *Recent Economic Changes in the United States,* 1929, Vol. 2, especially pp. 466-478; *Report of the President's Conference on Unemployment* (Government Printing Office), 1921; Douglas, Paul H.: *Real Wages in the United States,* 1930, Part IV, pp. 403-461; *Survey Graphic—Unemployment number,* April, 1929; *Hearings before a Sub-Committee of the Committee on Commerce, United States Senate,* 1930; *Hearings before the Committee on the Judiciary, House of Representatives,* 1930.

Japanese Industrialists Visit the United States

THE Director of the Japanese Branch of the Taylor Society, Mr. Yoiti Ueno, who is also Chief Director of the Institute of Industrial Efficiency, Tokyo, has recently conducted a party of sixteen Japanese industrial leaders across the country, from Seattle to New York and from New York to San Francisco, under our auspices. The party, which landed on August 22 and sailed on October 18, included: Haruo Aoki, Naigai Amimono, K.K.,[1] Tokyo; Ippei Eano, Nippon Toki, K.K., Nagoya; Riiti Ezaki, Ezaki, K.K., Osaka; Kichizo Furuya, Koshinsha, Tokyo; Jun Isagawa, Nitto Seiko Kojo, Nagoya; Risaburo Kato, Nippon Toki, K.K., Nagoya; Tetsujiro Mizusaki, Yamasa Shoyu, K.K., Choshi; Kozo Nishikawa, Toyo Toki, K.K., Kokura; Kadzue Oishi, Chiyoda Seika, K.K., Tokyo; Bungen Suzuki, Meiji Seito, K.K., Tokyo; Kijiro Takano, Minami Manshu Tetsudo, K.K., Dairen; Tomikiti Takeda, Nihon Kyoryo, K.K., Osaka; Rimpei Tominaga, Koshinsha, Tokyo; Keizo Tsujimoto, Fukusuke Tabi, K.K., Osaka; Shinzo Yoshida, Nakayama Taiyodo, Osaka.

Under Mr. Henderson's direction, reception and arrangements committees of Taylor Society members and civic organizations were organized in approximately twenty-five cities with the result that the group was given an exceptional opportunity to see American industry in operation.

To representatives of the press Mr. Ueno said: "Our common interest is to study American industry and the application of scientific management in your plants, but we find that the most important thing is to know each other. If we can know each other there will be no fights. I hope you will come to Japan and study Japan as we are studying your country. Then we can return your kindnesses." It was the opinion of the group that mechanical methods were on a higher plane than management methods in this country. They expressed the belief that diligent study of scientific management on the part of small industries as well as mass production plants would yield large returns to American industry.

The party was entertained in New York at a reception given jointly by the Taylor Society and the New York Metropolitan Section of the Taylor Society. The Japanese gentlemen in turn were hosts at the Nippon Club to Mrs. Frederick Winslow Taylor, Colonel and Mrs. Hathaway, who recently visited Japan, and the entire staff of the Taylor Society. Limitations of space prevent the mention in detail of the many courtesies that were extended to the Japanese visitors but it is our desire, and the desire of our guests, to take this opportunity to express deep appreciation to our members and friends for their invaluable assistance in entertaining Mr. Ueno and his party.

Scientific Management in the Program of the United Textile Workers of America

PRESIDENT McMAHON'S report to the officers and delegates of the Fourth Biennial and Twenty-ninth Annual Convention of the United Textile Workers of America, held in New York on September 8, 1930, contains a section on

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[1] K.K. is the abbreviation of "Kabushiki Kaisha" which means "company limited."

"Scientific Management and Research" in which he says the following:

"We are on friendly terms with a society of engineers recognized by employers and public representatives, as well as labor officials, as fair and impartial. A great number of the members of this society are imbued with the thought that scientific management and research can only attain its full end by giving the greatest protection possible to the human element in industry—the thing most needed, for without it chaos and strife will ensue when opportunity presents itself to the workers."

Among the committees appointed at this convention was one on "Organization and Scientific Management in Industry."

News of the Sections

Central New York

At the opening meeting of the Central New York Section of the Taylor Society on October 31, in Syracuse, Mr. W. J. Austin, of Cleveland, talked on "The Russian Situation and Establishing the Manufacture of the Austin Car in Russia."

New York Metropolitan

The first meeting of the New York Metropolitan Section on October 9, at the Fraternity Clubs, was given over to a discussion of rationalization and scientific management. Dr. Person, who has been interested in following the rationalization movement in Europe, was the principal speaker. John Gaillard, of the American Standards Association, discussed his paper, and an interesting open discussion followed.

Reviews

Group Incentives. By C. C. Balderston, University of Pennsylvania Press, Philadelphia, 1930, pages xi, 171.

This volume, Number IX, Research Studies of the Industrial Research Department of the Wharton School, is an appropriate and well-done work upon a subject that is of commanding importance in the management field today. It is based upon a serious and detailed study of group incentive plans as successfully operated in more than fifty industries and offices of various sizes and in many localities.

Those who approach the subject of group incentives for the first time, or, as a matter of fact, those who have had group plans under contemplation or in actual operation, will find that this book is charged with practical suggestions, derived from contact and experience, that are well-expressed and properly emphasized. The importance of the group incentive as one of the more recent devices of management is strongly brought out, but the dependence of this new device upon the fundamental elements of scientific management—accurate determination and fixing of standards and time study—is emphasized.

The overall excellence of the volume far overshadows its shortcomings, but to the reviewer it seems that there are some of these. The text seems to include too constant a reference to the detail of this or that company's plans, usually in respects that are adequately covered in the Digest of Typical Plans—Appendix D. There is some unnecessary repetition of details in the text itself but altogether the main text is too well done to necessitate the obvious repetition in Appendix A, where much of the text material is given again and no essentially new facts are developed. Chapter VI, Social Problems Raised by Incentives, seems to deal with the problems produced by incentive methods generally and not to distinguish sufficiently in favor of the specific additional problems of the group method.

Finally, a real regret is had because no space is given to the detailed working out of a typical plan for a representative small group, showing composition of group, base rates and basis for their determination, production rates, indirect labor factor, etc., so that a reader who is otherwise inspired by the book would, after study, have sufficient specimen data readily to proceed with the construction of a plan for his own plant.

ERNEST G. BROWN[1]

Work Routing in Production. By John Younger, The Ronald Press Company, New York, 1930, pages ix, 115.

In this little volume Professor Younger has presented material which he has used successfully for several years in his industrial engineering classes at Ohio State University. He discusses rather briefly the practices to be followed in planning production in a machine shop and the advantages which should result from this procedure. This book contains very little material which is not already known to executives of all well-managed plants.

As a text for college courses dealing with planning and related subjects this book will undoubtedly find a market although there are several other books covering the same subject already in use. The problems at the end of each chapter add materially to its value for this purpose.

Budgetary Control of Distribution. By T. O. Grisell, Harper & Brothers, New York, 1929, pages xvi, 99.

Here is a clear-cut application of the principles of scientific management to the field of distribution. Mr. Grisell has very ably presented not only the advantages to be gained from the preparation of a carefully planned sales budget, but also a simple procedure for its development. His experiences as Director of Marketing for a large advertising agency have made it possible for him to include a vast amount of actual data to substantiate his conclusions. This volume, therefore, contains results rather than theoretical or academic proposals.

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The author points out that any sales program which is based only on political areas or population is inadequate. He advocates a thorough analysis of all sales data and the setting of scientifically determined standards against which actual results may be checked before any expenditures are authorized. Any discrepancy between actual and standard should be traced to the one responsible and the causes ascertained. Detailed methods for securing control over this phase of a business are quite adequately discussed.

Sales executives, comptrollers and others interested in the control of distribution expenses will find this little book filled with valuable suggestions.

P. E. HENDERSON[2]

The Control of Distribution Costs and Sales. By William B. Castenholz, Harper & Brothers, New York, 1930, pages viii, 194.

The author sets for himself the task of consolidating the principal contributions to cost accounting as they relate to distribution costs. In eleven well-chosen and easily readable chapters he has placed most of the good sales cost accounting ideas that have been developed in the past decade. This book should be of especial interest to those who would like to become familiar with the principal body of distribution cost philosophy and some of the practices. If this book were read carefully by several thousand sales and chief executives in sizable concerns and if they demanded that their accounts and statements be prepared in conformity to the main body of philosophy in it the results produced would be great enough to relieve much of the strain of a business depression. Executives and accountants generally should read this book.

Those who are familiar with orthodox accounting and with more or less "modern" accounting will be interested in the conversion of an orthodox accountant of repute to modernism. The reviewer was particularly interested in the efforts of the author to keep his peace with orthodoxy (p. 4) and at the same time place business upon a research basis (p. 33), value the executive balance sheet on the basis of present values (p. 78), forecast the future (p. 70), break up the general profit and loss statement so that it will mean more than a truism or broad generality (p. 128), and meaningless below the gross profit point (pp. 146, 159), treat interest as a cost (p. 134), show that "actual facts" and "actual expenditures" (as so often claimed by orthodox accounting) are not reliable and may be obstructive to a sound interpretation of transpired events (pp. 150-151), advocate standard distribution cost (ch. X) and, finally, acknowledge that it will take time to induce accountants to use standards in their work (p. 152).

The reviewer agrees with the author that it will take some time to educate accountants to employ the philosophy and technique which is set forth in this book. The executive, we believe, is becoming cognizant very fast of the shortcomings of general orthodox accounting and of the fact that in time he will force the use of standards upon the accountant or displace him for one who will. How soon this will become general no one knows, but that it will come is certain.

The author contends that, broadly speaking, there are but two principal functions of a business, namely: production and distribution. Production, he says, (as is confirmed by many executives) is far ahead of distribution in general efficiency but distribution is very wasteful and inefficient. What is needed to assist in the solution of the distribution problem is better costing for the marketing activities. This is the main theme of the book and it is in agreement with the principal body of doctrine developed during the past decade or so. The illustrations given of the operation of standard distribution costs are concise.

Since this work has as its express purpose the bringing together and co-ordinating of the best ideas on distribution costs it may be well to point out some subjects which are not treated. The first is the concept of cost variations. Actual cost may vary from standard costs for some time without reflecting the inadequacies of the standard. We need to know why the costs varied from standard, in units and prices, before the figures can be placed in their true setting. The second relates to budgeting distribution activities in such a way that the variations between budget and performance can be analyzed into their components and the causes for variations assigned in terms of units and prices.

On the whole the reviewer has nothing but praise for the book and he is glad that Mr. Castenholz wrote it.

MONARD V. HAYES[3]

Unemployment and Purchasing Power. By P. W. Martin, P. S. King & Son, Ltd., London, 1929, pages vii, 85.

This small volume, preliminary to the publication of a more detailed study, presents a technical analysis of the relation between unemployment and monetary policy. At the heart of the problem is the question of purchasing power. The setting is England, but the theories and principles involved are pertinent to the situation in any country faced with the problem of unemployment.

Many explanations have been given for the unemployment situation in England during the past decade, but little thought has been directed to the root of the matter, namely, the maintenance of a free flow of demand and supply between the community and industry. Goods and money are exchanged only when the former are available at a price which the community can pay for them. "The whole question depends on whether or not there is a deficiency of purchasing power."

A deficiency in purchasing power tends to result from one or both of two situations, i.e., the unloading upon the market of stocks of commodities which industry no longer wishes to hold and the reduction of the total quantity of money in circulation. Purchasing power may be short-circuited through obtaining money from the community directly through borrow-

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